MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

Science

. . . For Life is not for science, but science for life. And even more than science, to our way of thinking, is the individual development of the scientific way of looking at things. Science is our legacy, we must use it if it is to be our very own.

J. Arthur Thomson
in The Outline of Science

JULY 1922

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Contributors and Contributions

Some Notes on Railway Refrigerator Cars

W. H. WINTERROWD

Data on principles and methods involved in refrigerator-car operation and on types of cars and methods of construction appear in a paper by W. H. Winterrowd, of Montreal. Mr. Winterrowd is at present chief mechanical engineer for the Canadian Pacific Railway and has had a wide experience in the design and construction of both cars and locomotives. He received his B.S. degree from Purdue University in 1907 and became a special apprentice for the Lake Shore and Michigan Southern Railroad immediately after his graduation. He was roundhouse foreman at Alliance, Youngstown and Cleveland, successively, from 1908–1910. In April, 1910 he became assistant engineer at the Cleveland shops, and the following year chief draftsman. In July, 1912 he became associated with the Canadian Pacific Railway as mechanical engineer and has been with this company ever since.

During the War Mr. Winterrowd accompanied Sir George Bury to Russia to study transportation conditions there, and was in Petrograd when the Revolution took place. In 1920–1921 he was President of the Canadian Railway Club, and he is a member of the general committee of Division V—Mechanical, American Railway Association.

The Accuracy of Boiler Tests

Alfred Cotton presents a valuable paper which discusses the various factors which enter into boiler-test computations, the errors which may be made and the best methods of reducing them. Mr. Cotton was born in England and there received his education and experience. He came to the United States in 1903 where he developed the "Cotton furnace" as a steam-jet forced-draft furnace of high efficiency and in 1905 he went into the business of manufacturing his furnaces. This project was given up during the War, and Mr. Cotton went with the Colt Patent Fire-Arm Manufacturing Co. In 1918 he became chief engineer in the combustion department of the Sterling Blower Co. and in 1919 he took his present position of research engineer for the Heine Boiler Co. of St. Louis.

Economics of Water-Power Development

Production, maintenance, selling costs and fixed charges in water-power development are discussed in a paper by Curtis A. Mees of Charlotte, N. C. Mr. Mees has had considerable experience in the design and operation of power plants since receiving his B.S. and C.E. from the Rose Polytechnic Institute. He was assistant engineer for the Catawba Power Co. at Rock Hill, S. C., and resident engineer with Herring and Fuller in Columbus, Ohio, where he worked on the design of the water-purification plant and the construction of the sewage-disposal plant. From 1905–1916 Mr. Mees was designing engineer for the Southern Power Co. at Charlotte, N. C., designing a number of their hydroelectric power plants. In 1916 he began private practice, since which time he has designed and built hydroelectric plants throughout the Southern states, and the Municipal Lighting and Gas Plant at Tallahassee, Florida.

Heat Losses from Pipe

As Industrial Fellow at the Mellon Institute of Industrial Research in Pittsburgh, R. H. Heilman has recently done research work on methods of heat flow and thermal properties of commercial pipe coverings. In 1917 he was in charge of the installation of a large dynamometer outfit for the Institute and did research work on electric-furnace design and construction. Mr. Heilman was educated at the University of Pittsburgh in electrical engineering and has had experience with the Pittsburgh Transformer Co., at the Oliver Power Plant, and with the Tarentum Light and Power Co.

The Control of Boiler Operation

E. A. Uehling, whose paper on the Control of Boiler Operation appears in this issue, is the inventor of the Pneumatic Pyrometer, the Uehling Pig Casting Machine, the Continuous Recording CO_2 Meter and a number of other devices. He was graduated from the Stevens Institute of Technology in 1877 and the next year assisted Dr. Thurston during his investigation of cold-rolled iron and steel. After several years experience in laboratories, he became superintendent of the Sharpsville Furnace Co. Later he was superintendent of blast furnaces for the Bethlehem Iron Co. and the Sloss Iron and Steel Co. at Birmingham, Ala. In 1895 he organized the Uehling Instrument Co., and was its President until his resignation in 1918.

Steel for Forge Welding

Frank N. Speller has been since 1904 a metallurgical engineer with the National Tube Co. at Pittsburgh. His paper discussing steel for forge welding is the result of extensive research and practical experimental work in the steel industry. After receiving his B.A.Sc. from the University of Toronto in 1894, he became city chemist for Toronto. He was a Fellow in Applied Chemistry at the University for a year and then became research chemist for the National Tube Co. at McKeesport, Penna. Since assuming his present position he has developed a new type of roll to improve the working of skelp, a new process for finishing pipe to remove scale, and a method for the control of corrosion in hot-water pipes and boilers.

The Evaporation of a Liquid into a Gas

This paper, which reports the results of investigations of the evaporation of a liquid into a gas, is by the head of the Department of Chemical Engineering at the Massachusetts Institute of Technology, W. K. Lewis. Prof. Lewis received his degree in chemical engineering from this institution in 1905 and three years later his Ph.D. under Abegg in Breslau, Germany. Since that time he has been continuously engaged in industrial research and consulting work, and for the past twelve years has been in the Department of Chemical Engineering at the Massachusetts Institute of Technology. During the War Prof. Lewis was in charge of research work on gas masks and other protective devices against toxic gases, first with the Bureau of Mines and later with the Chemical Warfare Service.

MECHANICAL ENGINEERING

Volume 44 July, 1922 Number 7

Some Notes on Railway Refrigerator Cars

A Collection of Facts Relating to Principles of Railway Refrigerator-Car Operation and Information About Various Types of Cars and Methods of Design and Construction

By W. H. WINTERROWD,[1] MONTREAL, QUEBEC, CANADA

An efficient and economical railway refrigerator car is one which provides adequate air circulation, adequate protection to the lading, adequate quantity and degree of refrigeration, quick initial cooling, uniform temperature, dry air, space to permit proper methods of loading, and good car construction to minimize maintenance and increase time in service.

The literature of this subject being to some extent scattered, this paper is an attempt to include under one heading some of the most interesting and important facts regarding principles and methods involved in railway refrigerator-car operation, as well as to present some information regarding the types of cars and methods of construction used by various railways and private-car owners.

The data were collected directly from the railways and private-car owners in an endeavor to sense the general trend of design and construction, and as there are signs on the horizon which indicate a renewed activity in the construction of railway equipment, this information is presented in the hope that it will serve to reëmphasize the great importance to the railways of efficient and well-maintained cars of the refrigerator type.

THE importance of efficient and well-maintained railway refrigerator cars to the people and railways of North America cannot be overemphasized. The *Railway Equipment Register* for March, 1922, shows that the railways and private-car owners own approximately 153,000 cars of this type; figures from the same source indicate that this is about 6 per cent of all the cars owned, and approximately 13 per cent of all the box- or house-type cars listed.

Refrigerator cars are important in the life of the people because they are used principally to carry the bulk of the nation's perishable foodstuffs. They are important to the railways because they are factors in the production of revenue. When hauls were short and the variety of perishable commodities few, the problem of transporting and protecting the commodities from heat or cold was comparatively simple. Increasing distances and a greater variety of perishables not only made necessary greater numbers of, and more efficient, cars, but involved the establishment of railway divisional and terminal facilities, upon which the successful operation of this type of equipment is contingent.

In this paper the author has attempted to include under one heading some of the most interesting and important facts regarding principles and methods involved as well as to present some information regarding the type of cars and methods of construction used by various railways and private-car owners. The data were collected directly from the railways and private-car owners in an endeavor to sense the general trend of design and construction, and as there are signs on the horizon which indicate a renewed activity in the construction of railway equipment, this information is presented in the hope that it will serve to reëmphasize the great importance to the railways of efficient and well-maintained cars of the refrigerator type.

The information which follows deals entirely with cars in which refrigeration is obtained by means of ice and salt. Many interesting efforts have been made to evolve a mechanical means of refrigeration, but the problem has been difficult of satisfactory and economical solution.

[1] Chief Mech. Engr., Canadian Pacific Railway Co. Mem. Am.Soc.M.E.

Abridgment of a paper presented at a joint meeting of the Metropolitan Section and the Railroad Division of the A.S.M.E., and the A.S.R.E., New York, May 16, 1922. All papers are subject to revision.

Refrigeration of Commodities in Transit Involves Many Factors

The prevailing method of obtaining refrigeration is by means of naturally circulated air cooled by contact with ice, or ice and salt, placed in suitable receptacles called bunkers located at each end of an insulated car. Some modifications of this system will be touched upon very briefly later.

Circulation is assisted and made most efficient by means of insulated partitions, called bulkheads, placed in front of the containers and so constructed that the relatively warm air must pass over the top of them to reach the ice, or ice containers. The air becoming chilled, and therefore heavier, sinks toward the floor and reaches the body of the car by passing through a space beneath the bulkheads.

These insulated partitions also assist in protecting the lading nearest the ice containers. Without bulkheads, and when salt is used with the ice to hasten and increase refrigeration, that part of the lading nearest the ice frequently freezes, an undesirable and disastrous occurrence with some commodities. At the same time that portion of the load near the center and top of the car may remain at too high a temperature, an equally undesirable condition.

As a further aid to circulation, particularly in cars where the

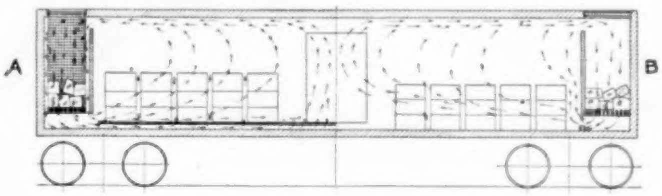


Fig. 1 Diagram of Air Circulation

lading is piled or stacked, a slatted wooden structure known as a floor rack is of very great value. These racks, on the top of which the lading may be placed, consist of longitudinal runners 3 or 4 in. high, with cross-slats fastened to the top of them. They are hinged to the side walls of the car and are divided in the middle so that they can be turned up to make the floor accessible. These racks permit the cold air which flows beneath the bulkhead to circulate freely toward the center of the car and up through the lading.

Illustrations of Effect of Design

The "A" end of the car, Fig. 1, shows the relative arrangement of bunkers, bulkheads, and floor racks, and the resultant trend of air circulation.

It is highly desirable that there be no obstruction to the flow of cold air where it passes beneath the bulkheads. The "B" end of the car, Fig. 1, shows how an obstruction at that point can act as a dam or deflector of the air currents, and partly or entirely defeat the object of the floor racks, and even cause frosting of the lading against the insulated bulkhead. If floor, bunker, or splashboard construction necessitates a ledge beneath the bulkhead, it should be kept as low as possible and the floor rack and bulkhead so designed to provide sufficient area for a free flow of air. At the "B" end the lading is shown piled directly on the floor and the air currents directly indicate the advantage of floor racks.

To obtain the greatest advantage from circulation, the contents of the car should be loaded so that the air can come in contact with a maximum surface with a minimum of restricted circulation. It is easy to understand that boxes or containers placed closely against each other and against the walls of the car cannot be cooled quickly or properly preserved at as uniform a temperature as when placed so that air can flow between them, or generally speaking, throughout the entire load.

The temperature of the circulating air is affected by the type and size of ice containers or bunkers. The chief considerations in the construction and capacity of the bunkers are the refrigeration required to replace the loss due to transmission and the refrigeration

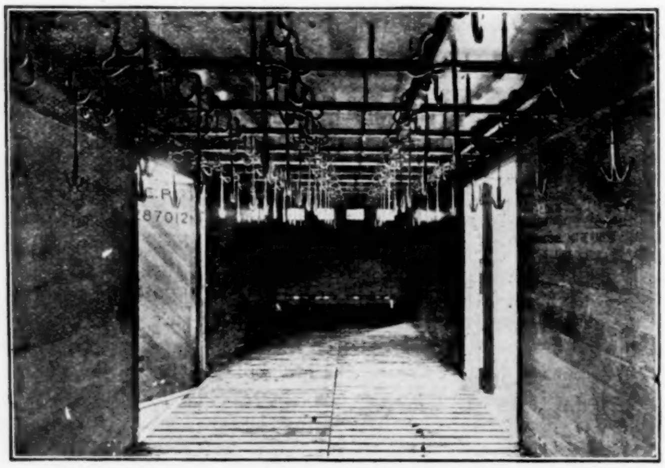


Fig. 2 Meat Rack and Hook Installation

required to cool the car quickly and maintain its contents at the required temperature. The loss in transmission in turn depends upon insulation, car construction and maintenance; factors which will be more fully discussed later.

A basket bunker is shown in the "A" end of the car in Fig. 1, and a box bunker in the "B" end.

The sides of the basket bunker are constructed of wire mesh. The bottom consists of a slatted wooden structure. The bunker is placed in position so that air space exists around the outer surfaces, this construction permitting the air behind the bulkhead to come in contact with a maximum ice area, while the open spaces around the bunkers facilitate circulation.

The bottom of the box bunker shown at the "B" end of the car in Fig. 1 is also slatted. The walls are formed by the bulkhead and by the sides and end of the car. In an endeavor to make the refrigerator car more productive and useful for general purposes, some builders have applied collapsible box bunkers. In this design the bulkhead is swung up, or to one side, and fastened. The slatted rack is swung or folded back against the end of the car. In this way the space occupied by the bunker is made available for general lading.

Another very important factor is the size of the car and its proportions, particularly with reference to the distance between the bulkheads. If this distance is too great, the air may not be at a low enough temperature when it reaches the center of the car to properly refrigerate the load at that point, particularly near the top of the car. Under such conditions a portion of the load near the bulkheads may be sufficiently chilled while the upper and center part of the load may be too warm.

Importance of Temperature of Entering Load

If heat is not removed from certain commodities prior to loading it is highly desirable to remove it as quickly as possible after loading. Tests and general experience show that if the heat is not promptly reduced, the commodities either spoil en route or reach their destination in such condition that their market value is greatly reduced. Quick cooling after loading is generally attempted by precooling the car, by the use of cars in which maximum and most efficient air circulation can be obtained, and by mixing a proper amount of salt with the ice or by placing coarse rock salt on top of the ice.

Precooling the car may be accomplished by the use of ice and salt, but at many points where a large tonnage of fruit or meat originates, the cars as well as the lading are often precooled by mechanical means.

Precooling means less ice in transit, a matter of economy to shippers and railways alike. Some commodities can be frozen hard and therefore require little or no icing en route, the lading itself supplying the necessary refrigeration. This not only insures better condition in transit but is an added economy.

Humidity or moisture content of the air in the car is almost as important as temperature. Generally speaking, if refrigeration is effective and a high initial rate of cooling obtains, the air is kept sufficiently dry due to condensation taking place on the surface of the ice, or ice containers. In this way the moisture given off by some classes of lading is also deposited. Excess of humidity, if not fatal, is highly injurious to many commodities.

Insulation the Most Important Consideration

Finally we come to the matter of insulation, the most important factor in connection with efficient and economical refrigeration in a railway car. The function of the insulation is to afford protection to the lading by minimizing heat transmission through the

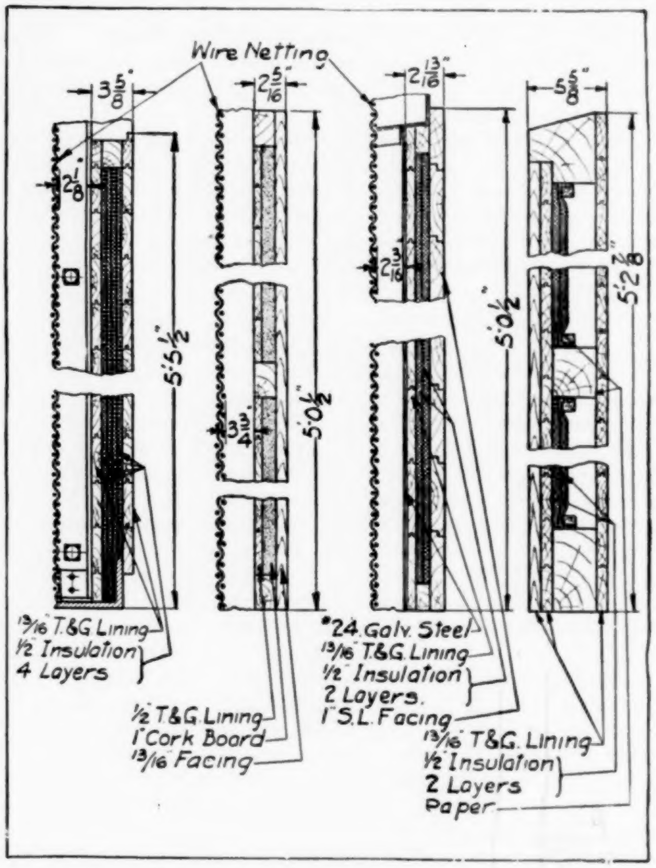


Fig. 3 Cross-Sections of Bulkheads

walls, roof, and floor of the car. To do its work properly it must be by nature a poor conductor of heat. Other desirable qualifications are reasonable cost, strength, adaptability, durability, light weight, and imperviousness to moisture.

This subject might well be divided into two parts, insulating materials and insulation, because the general subject involves methods of car construction and maintenance in addition to the consideration of materials and principles of heat transmission.

The whole subject is capable of analysis, but that the principles involved are not broadly known is indicated by the fact that in very recent years cars have been built without proper or sufficient insulation. These cars, which do not properly protect their lading, are huge consumers of ice and expensive to operate and require a great deal of maintenance to keep them in service.

It is evident from the foregoing that an efficient and economical

railway refrigerator car is one which provides adequate air circulation, adequate protection to the lading, adequate quantity and degree of refrigeration, quick initial cooling, uniform temperatures, dry air, space to permit proper methods of loading, and good car construction to minimize maintenance and increase time in service.

SOME NOTES ON EXISTING CARS

In an endeavor to sense the trend of refrigerator-car design, proportions, and construction, the author addressed an inquiry to a number of railways and private-car owners. The replies, while not complete, were very generous. A comparison of the most interesting returns is shown in Table 1, and makes a very interesting study, although in any consideration of this table the fact must not be overlooked that possibly some of the railroads or owners, if building equipment today, might modify their designs.

Every road or owner represented owns at least one thousand cars. As far as possible the cars shown were chosen from quantities built in comparatively recent years.

Types of Cars and Ice Containers

Generally speaking, the cars can be divided into two types: one equipped with brine tanks and generally used for carrying meats; the other, equipped with bunkers and used principally for carrying commodities such as eggs, butter, vegetables and fruit.

In connection with this distinction, based on ice containers, it is interesting to note that Dr. Pennington has stated that a car of the basket-bunker type, such as the U. S. Railway Administration Standard, will carry meat hung from rails quite as successfully as a car built especially for meat. The statement is also made that there is not visible in practical results the advantages supposed to accrue from the retention of the brine, provided coarse rock salt is place on top of the ice in the bunker and so forced to bore its way through the whole mass before finding an exit.

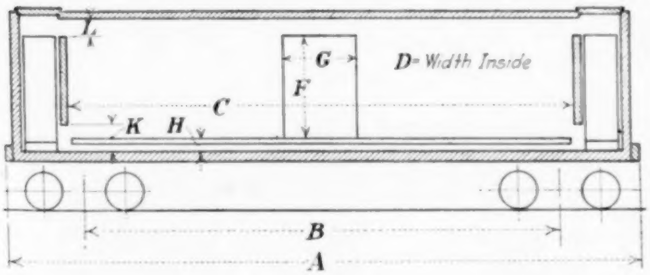
But there is a very important problem in this connection that must not be overlooked if salt is to be used with ice in a basket bunker, and that is the method of disposing of the brine. It is common knowledge that if brine falls on journal boxes, side frames, arch bars or other truck parts, as well as upon rails, tie plates, bridge members, etc., the resulting damage is great and a factor involving heavy maintenance cost.

The subject is so important that the American Railway Association interchange rules specify that after July 1, 1922, no car carrying products which require for their refrigeration the use of ice and salt and which are equipped with brine tanks, will be accepted in interchange unless provided with a suitable device for retaining the brine between the icing stations.

Twenty-seven railroads and owners are represented in Table 1. Out of this number the principal cars of sixteen are equipped with bunkers and the remainder with brine tanks. Out of the sixteen, eleven or practically 69 per cent are of the basket type; the remaining five, or approximately 31 per cent, are of the box type. The majority of the cars recently built, or now under construction are equipped with the basket type of bunker. The demand for refrigeration and the special-service car, as well as greater efficiency of the permanent basket type, appear to be decreasing the demand for the collapsible bunker.

Another distinction that prevails and will prevail as long as cars are built for some particular service is the difference in construction due to the commodity to be transported.

In meat cars the lading is hung on hooks suspended from a meat rack placed just below the ceiling. This rack generally consists of stringers and cross-bars supported by the roof and walls of the car. In a car of this type it is necessary to make the framing heavier so that in addition to its other functions it will adequately support the weight of the lading. A meat rack



Sketch Showing Dimensions Referred to in Table 1

and hook installation is illustrated in Fig. 2. Very often additional lading is stowed or placed on the floor racks beneath the suspended load, in order to obtain the full carrying capacity of the car.

Bulkheads.—The majority of the cars tabulated are equipped with solid bulkheads. These are either built into place or are hinged from the walls or ceiling so that they can be swung open. A few cars, however, are equipped with the syphon system, in which the bulkhead consists of a framework holding a series of galvanized iron louvres supposed to direct the air back and down into the bunkers.

The general trend seems to be to use two layers of $^1/_2$-in. hair felt between two walls of $^3/_{16}$-in. matched-and-dressed wood lining. An interesting exception, and on a quite recent car, is the use of one layer of 1-in. cork insulation. Some bulkheads are constructed of two walls with a few layers of waterproof paper between them. Occasionally an air space is contained between the walls. In one instance, in addition to a dead-air space, two layers of $^1/_2$-in. hair felt are provided. Some cross-sections of bulkheads are shown in Fig. 3.

Space Below Bulkheads.—The space between the bottom of the bulkhead and the car floor varies considerably, ranging from 7 in. to 2 ft. 7 in. On the car with the 7-in. space the bulkhead is brought right down to the level of the floor rack. On the bottom of this bulkhead a canvas strip is fastened to prevent cold air passing out above the racks. The cars with the very large openings at both bottom and top of bulkheads are generally used for meat shipments.

The majority of cars have a bottom opening of from 9 to $15^3/_4$ in. The average is about 12 in.

As the floor racks on these cars average about $4^1/_2$ to 5 in. in height, it can be seen that the cold air has access to the body of the car above the rack as well as through the space beneath it.

The author has endeavored to ascertain if there is any relation between

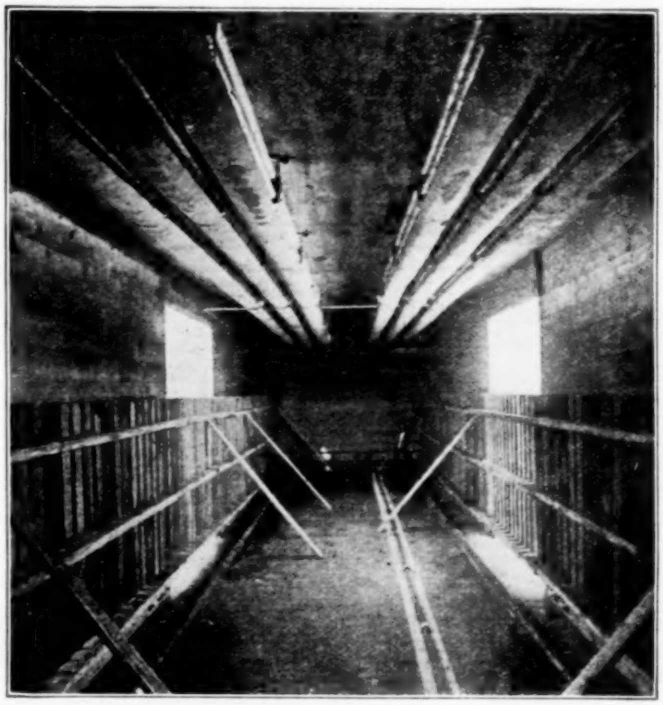


Fig. 4 Interior of Car with Overhead Brine Tanks; Showing also Heater Pipes on Floor

the size of the openings above and below the bulkhead and the velocity of the air in circulation, but inquiry has not produced anything definite. There is some unanimity of opinion, however, in favor of the design in which there is an opening of from 2 to 7 in. above the floor racks.

In the matter of efficient refrigeration the distance between bulkheads is an important one. The tabulation shows that this varies between 28 ft. 8 in. and 38 ft. 10 in. The general trend is between 32 and 34 ft. On the latest cars the spacing is approximately 33 ft., or slightly greater. The size of the standard egg crate has been a large factor in the establishment of the exact dimension.

Car Construction and Maintenance

An impression seems to prevail that the life of a railway refrigerator car is about six to eight years. In 1919 a committee of the Mechanical Section of the American Railway Association reported that the average life of railroad-owned wooden refrigerator cars, dismantled was 17.1 years, and of private-line wooden refrigerator cars, dismantled, 21.9 years, making the average life for all wooden refrigerator cars, dismantled, 19.4 years.

The life of refrigerator cars equipped with steel under-frames or steel framing and superstructure is a matter upon which there are few data, because such cars are comparatively modern. There seem to be no reasons, however, barring those of possible evolution, why such cars should not have a long life and require little for maintenance by reason of their better design and construction.

It is not difficult to appreciate the causes responsible for the high cost of maintenance of old wooden cars; the refrigerator type does not stand alone in this class. But in addition to more severe traffic conditions, this type of car had required attention on account of the difficulty in keeping moisture away from the insulation as well as from the wooden framing and flooring. If the insulation becomes broken, wet or sags so that air can circulate around it, the car rapidly loses its efficiency. Table 1 and the cross-sections in Figs. 5 to 13 inclusive, give a general idea of some types of cars, and what has been done to improve design and construction. Figs. 12 and 13 represent cars of relatively low efficiency. Figs. 5 to 11, inclusive, show more modern cars and indicate the more recent trend in the matter of improved insulation and general construction.

Table 1 Refrigerator Cars

(See sketch on page 421 for key to dimensions)

Service	Road or Owner	*A* Over Striking Castings, ft-in.	*B* Truck Centers, ft-in.	*C* Between Bulkheads, ft-in.	*D* Width Inside, ft-in.	*E* Height Clear, ft-in.	*F* Door Height, ft-in.	*G* Door Width, ft-in.	*H* Height of Floor Rack	*K* Height Opening Below Bulkhead	*L* Height Opening Above Bulkhead	Type of Bulkhead	Tank or Bunker
Freight	1	42–5¼	31–2	34–4¾	8–7⅜	6–8 Meat Rack 7–3½ Ceiling	6–9⅝	5–0	5½"	7"	16½"	Solid, Swinging to Side	Brine Tank
	2	41–8½	30–8	33–2¾	8–2¾	7–0 3/16	6–8½	4–0	4⅞"	12"	14"	Solid, Rigid	Basket Bunker
	3	42–1½	31–1½	33–2¾	8–2¾	7–0 7/16	6–8¼	4–0	4¾"	12"	12"	Solid, Rigid	Basket Bunker
	4	40–8½	29–10½	32–2⅜	8–0½	7–2	6–4¼	4–0	⅞" Slat	......	3½"	Swinging to Roof	Bunker (Collap.)
	5	34–0 Endsills	24–0	28–8	8–1	7–4½	6–0	4–0	....	2'–7"	17"	Solid, Swinging to sides	Brine Tank
	6	42–1½	31–1½	33–2¾	8–2¾	7–0 7/16	6–8¼	4–0	4¾"	2'–7" 12"	14"	Solid, Rigid	Basket Bunker
	7	36–11⅛	26–0	29–10¾	8–2¼	7–1⅞	6–3	5–0	4½"	12½"	14⅞"	Solid, Swinging to side	Brine Tank
	8	37–9½ Endsills	26–10	36–0 Bet. Ends	8–3⅜	8–0 1/16	7–0	6–0	....	....	....	....	Ice Boxes at roof
	9	37–10⅜	......	31–0⅛	7–9⅜	7–1⅜	5–9¾	4–0	....	2'–6"	16¾"	Solid, Rigid	Brine Tank
	10	42–1½	31–1½	33–1¾	8–2¾	7–1	6–4¾	5–0	4¾"	15¼"	11½"	Solid, Rigid	Basket Bunker
	11	40–10 Endsills	30–9⅜	33–5⅜	8–2⅜	7–5⅛	6–4	4–0	....	16"	12"	Solid, Rigid	Box Bunker
	12	43–3½	32–0	34–6	8–10½	7–3½	6–3⅛	4–0	....	12"	12"	Solid, Rigid	Basket Bunker
	13	41–2	30–1	32–10½	8–10½	7–2 7/16	6–5	4–0	4¾"	12"	10 15/16"	Slat Syphon Rigid	Box Bunker
	14	40–9½ Endsills	31–9½	33–6¾	8–2¾	7–0 7/16	6–8¼	4–0	4¾"	....	....	Rigid	Basket Bunket
	15	40–0 Endsills	30–0	32–6⅞	8–3¼	7–4 13/16	.....	4–0	15/16" Slats	11"	3¼"	Syphon, Swinging to Roof	Bunker (Collap.)
	16	40–0 Endsills	30–0	33–1½	8–3¼	7–4 13/16	.....	4–0	15/16"	15¾"	8¼"	Solid, Rigid	Box Bunker
	17	41–8	30–10	33–2¾	8–2⅝	7–2½	5–9¼	4–0	....	12½"	12"	Solid, Rigid	Basket Bunker
	18	41–4¾ Endsills	31–6	33–0	8–4⅞	7–2⅛	5–8⅛	5–0	5"	....	10"	Solid, Rigid	Basket Bunker
	19	40–0 Endsills	30–0	32–10	8–3⅝	....	6–2⅜	4–0	....	....	....	Slat Syphon Rigid	Box Bunker
	20	41–10	30–2	32–7	8–4⅝	7–4	5–10	4–0	...	10"	8"	SlatSyphon, Rigid	Box Bunker
	21	38–7⅝	26–10½	30–11½	8–4	7–1	5–11½	4–0	5"	9"	14"	Solid, Rigid	Box Bunker
	22	41–11½ Endsills	31–8¼	32–10	8–3	7–1 3/16	6–3⅝	4–0	5"	11⅛"	12"	Solid, Rigid	Basket Bunker
	23	37–3⅛	26–4	30–4⅝	7–10⅞	7–2 5/16	6–2¼	4–0	....	2'–4"	21"	Solid, Rigid	Brine Tank
	24	42–6	32–6	32–11½	8–4⅛	7–3 3/16	6–2	4–2	Slat	12"	12½"	Solid, Rigid	Basket Bunker
Passenger	25	48–8¾	34–0	38–4¾	8–7⅛	7–3½	6–9⅝	5–0	5½"	7"	18½	Solid, Swinging to sides	Brine Tank
	26	45–0 Endsills	33–8	38–10	8–1⅞	7–2½	6–3	5–0	4½"	10"	15"	Solid, Swinging to side	Brine Tank
	27	43–0	30–4	35–5	8–7⅛	7–4	6–3¾	5–0	4¼"	9⅛"	15¼"	Solid, Swinging to side	Brine Tank

Road or Owner	Floors: Wood	Floors: Waterproof Paper or Fabric	Floors: Air Space	Floors: Insul. Mat'l.	Floors: Kind of Insulating Material	Sides: Wood	Sides: Waterproof Paper or Fabric	Sides: Air Space	Sides: Insul. Mat'l.	Sides: Kind of Insulating Material	Type of Outside Roof	Roof: Wood	Roof: Waterproof Paper or Fabric	Roof: Air Space	Roof: Insul. Mat'l.	Roof: Kind of Insulating Material	Type of Underframe
1	4	2 Paper	2	4	½" Keystone Hairfelt	3	......	2	3	½" Keystone Hairfelt	Outside Metal	5	1 Paper	4	6	½" Keystone Hairfelt	St l
2	2	1 Paper	..	1	2" Cork	3	2 Paper	3	3	½" Keystone Hairfelt	Outside Metal	3	1 Paper	2	4	½" Keystone Hairfelt	Stee
3	2	......	..	1	2" Cork	3	3 Fabric	1	2	1" Insulation	Outside Metal	3	2	2	3	....	Steel
4	3	1 Paper	1	4	½" Insulite	3	4 Paper	3	4	½" Flaxlinum	Wood	5	5 Paper	3	4	½" Flaxlinum	Steel
5	5	8 Paper	3	1	1" Hairfelt	4	6 Paper	2	1	1" Hairfelt	Wood	5	5 Paper	4	2	1" Hairfelt	Steel
6	2	......	..	1	2" Cork	3	1 Fabric	1	2 1	½" Keystone 1" Hairfelt	Outside Metal	3	1 Fabric	2	2 2	½" Keystone ¾" Hairfelt	Steel
7	4	2 Paper	3	1 1	Keystone Woolfelt	3	4 Paper	2	1	Keystone	Wood	5	3 Paper	2	1 1	Keystone Sawdust	Steel
8	3	......	4	3	½" Flaxlinum	3	2 Paper	3	2	½" Flaxlinum	Outside Metal	3 6	....	2	4	½" Flaxlinum	Steel
9	5	6 Paper	3	1 1	½" Hairfelt 1" Hairfelt	3	3 Paper	3	1	½" Hairfelt 1" Hairfelt	Wood	3	....	5	2	½" Hairfelt	Wood
10	2	......	..	1	2" Cork	2	2 Paper	2	4	1" Flaxlinum	Outside Metal	3	1 Paper	2	1 1	½" Hairfelt 2" Hairfelt	Steel
11	5	1 Paper	2	3	½" Hairfelt	3	2 Paper	3	3	½" Hairfelt	Outside Metal	5	1 Paper	2	4	½" Hairfelt	Steel
12	5	4 Paper	3	4	Woolfelt	..	......	..	..	....	Wood	3	5 Paper	5	4	Woolfelt	Steel
13	4	1 Fabric	2	4	½" Flaxlinum	3	......	1	4	½" Flaxlinum	Outside Metal		....	2	5	½" Flaxlinum	Wood
14	2	......	..	1	2" Cork	3	2 Paper	1	4	½" Arctic Keystone	Outside Metal	3	....	2	1 2	½" Arctic Keystone	Steel
15	4	7 Paper	1	2	½" Flaxfelt	3	3 Paper	3	4	½" Flaxfelt	Wood	4	6 Paper	3	4	1" Hair ½" Flaxfelt	Steel Center Sills
16	4	1	2	4	½" Arctic Keystone	3	......	3	4	½" Arctic Keystone	Wood	4	....	3	4	½" Arctic Keystone	Steel Steel Center Sills
17	2	......	..	1 1	½" Insulite 1½" Cork	2	1 Paper	1	1 1	½" Insulite 1½" Insulation	Wood	3	1 Ruberoid 1 Waterproof Coat	1	1 2	2" Hairfelt ½" Insulite	Steel
18	3	......	1	1	2" Cork	3	2 Paper	2	4	½" Insulation	Outside Metal	3	....	2	4	....	Steel
19	3	1 Paper	2	2	½" Linofelt	3	2 Paper	3	2	½" Linofelt	Wood	3	1 Paper	3	1 2	½" Insulation ½" Linofelt	Steel
20	5	1 Fabric	3	3	½" Hairfelt	3	4 Paper	3	2	½" Hairfelt	Wood	5	6 Paper	4	3	½" Hairfelt	Steel
21	4	1	2	2	½" Hairfelt	3	2 Paper	3	2	½" Hairfelt	Wood	5	2 Paper	3	2	½" Hairfelt	Steel
22	2	2 Paper	1	1	2" Cork	2	9 Paper	1	4 2	½" Hairfelt Cork at bottom	Outside Metal	3	13 Paper	1	6	½" Hairfelt	Steel
23	5	5 Paper	3	3	½" Hairfelt	5	5 Paper	4	3	½" Hairfelt	Wood	5	7 Paper	4	3	½" Hairfelt	Steel
24	2	3	2	2	1" Corkboard	2	2 Paper	3	3 3	½" Keystone Cork at bottom	Outside Metal	2	2 Paper	5	4	½" Keystone	Steel
25	3	2 Paper	1	4	½" Keystone	3	......	2	3	½" Keystone	Outside Metal	5	1	4	6	½" Keystone	Steel
26	3	1 Paper	2	2	½" Keystone	4	1	1	4	½" Keystone	Wood, Canvas Covered	3	1 Canvas	2	4	½" Keystone	Steel
27	3	1 Paper	2	2	1¼" Tucork	4	......	4	3	½" Keystone	Inside Metal	3	....	3	4	½" Keystone	Steel

The cross-sections really speak for themselves, but a brief discussion under the separate headings Floors, Walls and Roofs will be of some interest.

Floors.—The chief problem in floor construction is to make the structure waterproof, as well as a good insulator.

The insulating value of all materials that absorb moisture is greatly decreased when water is absorbed. In addition, water causes most of the insulating materials popular in refrigeration construction to become mushy and sag or drop out of place. It also causes wood floors lining and framing to decay or weaken, thereby making it more difficult to keep the general structure tight.

Nearly all the modern or at least recently built floors employ a construction involving cork as an insulating material. To keep moisture away from the cork various waterproofing compounds or waterproof materials are used.

The one exception to this general trend is shown in Fig. 11, where the insulation consists of four massed layers of 1/2-in. hair felt. Moisture is kept away from the top of the insulation by means of two layers of floor boards between which is laid a layer of waterproofing compound. The surface of the top floor is covered with a layer of waterproofing compound into the surface of which sand has been rolled.

Figs. 12 and 13 show a floor insulation with intervening dead-air spaces. To be insulators, however, they must be dead-air spaces; for once circulation starts their efficiency is destroyed.

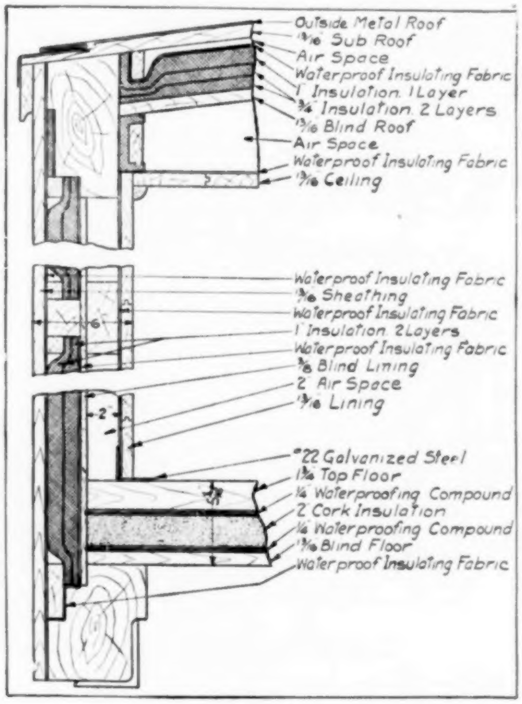


FIG. 5

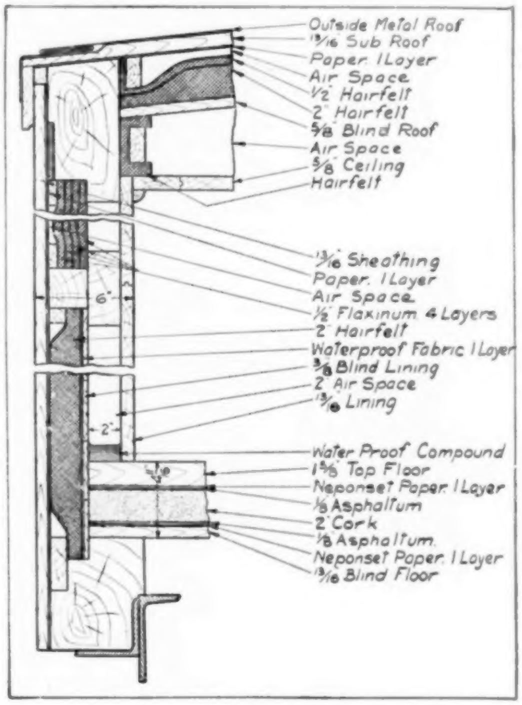


FIG. 6

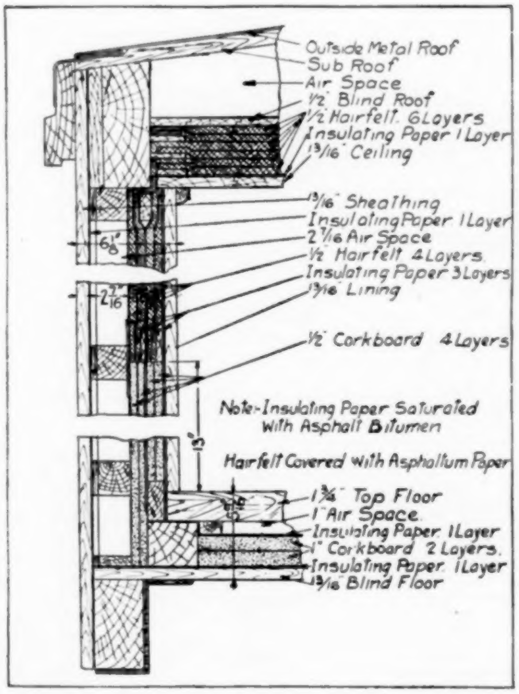


FIG. 7

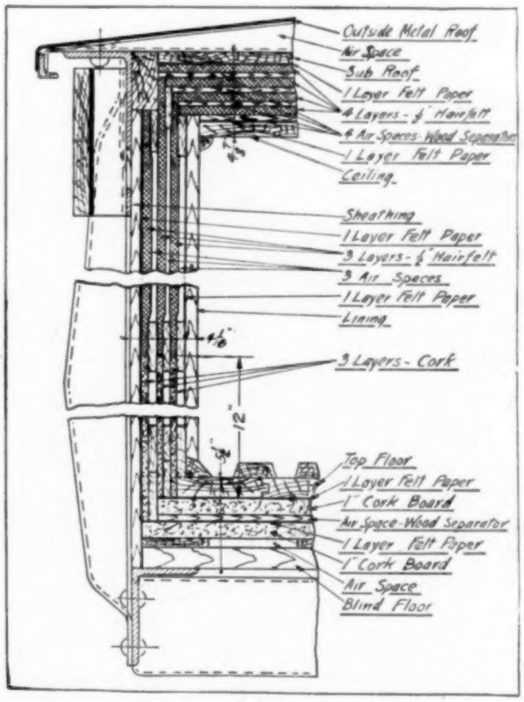


FIG. 8

FIGS. 5 to 8 TYPES OF REFRIGERATOR CARS

It has been intimated that in some cases cork as a floor insulator has not been entirely satisfactory because in time it becomes brittle and crumbles. Specific information on this subject would be very valuable, as it would indicate whether the trouble was inherent or due to some particular method of construction.

Walls.—In connection with a waterproof structure it is interesting to note the various methods employed at the junction of the floor and side walls to keep water from getting past the lining and into the insulation. This point has been a source of great trouble. Some particularly interesting methods of construction at this point are shown in Figs. 6, 9, 10 and 11.

An exceedingly interesting example of waterproof construction is con-

tained in some all-steel refrigerator cars designed by W. F. Kiesel, Mem. Am.Soc.M.E., Mechanical Engineer of the Pennsylvania Railroad. The proportions of these cars were described in the *Railway Review* of February 3, 1917. The body of the car consists of an all-steel container placed within an outer container, the space between the walls being filled with insulation. The writer understands that at the floor the sections of the inner container are welded together, thus making the floor practically one piece and watertight and thereby affording maximum protection to the insulation.

Inspection of the various cross-sections indicates a general trend toward massing wall insulation and eliminating air spaces between the layers of felt and the inner lining. The hair felt is protected at the floor line with canvas duck laid in white lead. The bottom of the insulation behind the sheathing is protected by waterproof compound poured into a channel or gutter provided for the purpose. The compound in this gutter joins the compound laid above the flooring cork thus forming a continuous waterproof section.

Roofs.—The tendency at present is to apply massed insulation in the roofs. As a rule the most modern cars have 2 to 2 1/2 in. of insulation applied in this way. The car shown in Fig. 7 is provided with 3 in. of such insulation.

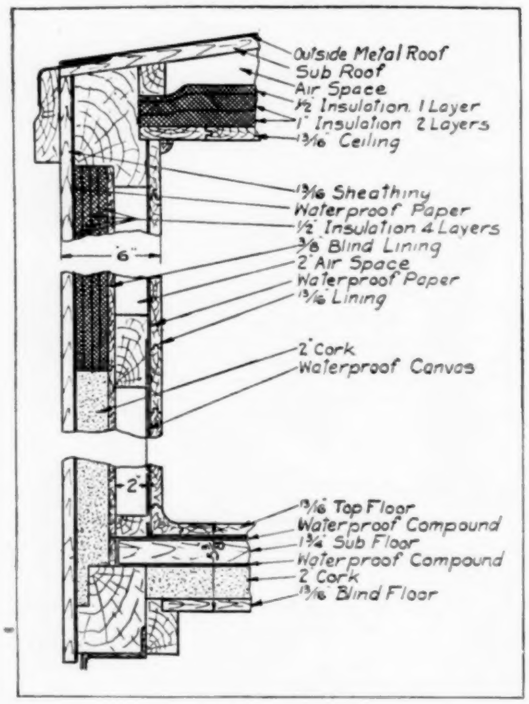


Fig. 9

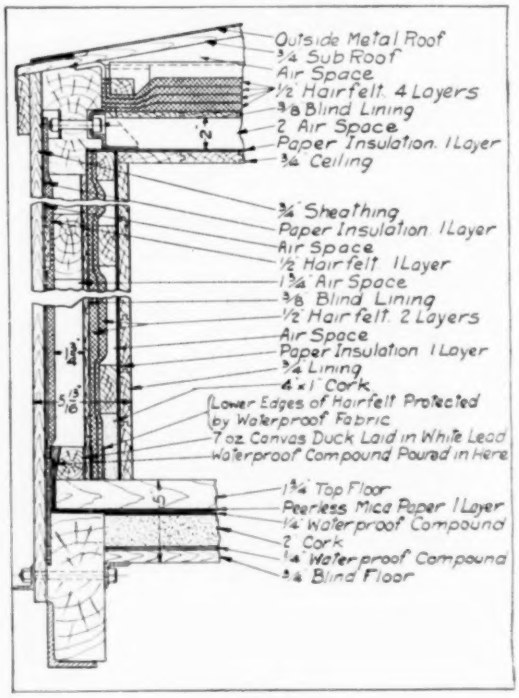


Fig. 10

insulation. As a rule the insulation is applied in a continuous strip from door post to door post. The advantage of applying insulation in this way lies in the fact that a continuous or unbroken surface presents no joints or openings through which air can pass or circulate. It has been the experience that where insulation is applied in sections, unusual construction is required to prevent eventual air circulation. Wall insulation is rarely less than 2 in. thick on the most recent cars. In some cases this insulation is applied in two massed layers. In one case the single layer is 2 in. thick. In the majority of cases four massed layers of 1/2-in. insulation are used.

The construction employed by the U. S. Railway Administration is indicated in Fig. 5 and shows the insulating material massed beneath the outside sheathing. Air space is provided between the inner lining and the blind lining. This construction was advocated as a method of preventing damage to the insulation should nails be driven through the inside lining.

A great many cars are insulated in this way, but there are some interesting exceptions, one of which is shown in Fig. 7. The advantage claimed for such construction is that of a car becomes cornered or damaged to such an extent that sheathing is out or broken, the insulation stands a much better chance of remaining intact or becoming only slightly damaged, and the lading not subjected to risk caused by loss of cold air. It is also claimed that by the use of properly constructed wood forms or spacers, and the proper loading methods, no necessity should exist for driving nails through the inside lining. A great many railroads are conducting an educational campaign in this connection. Two interesting wall structures are shown in Figs. 7 and 8. In these figures it will be seen that layers of cork board are used below the insulation, the hair felt starting at a point 13 in. above the level of the floor.

Another arrangement in which cork is used is shown in Fig. 10. In this cross-section the two inner and massed layers of hair-felt insulation come right down to the floor level. A slab of cork board is placed between the hair

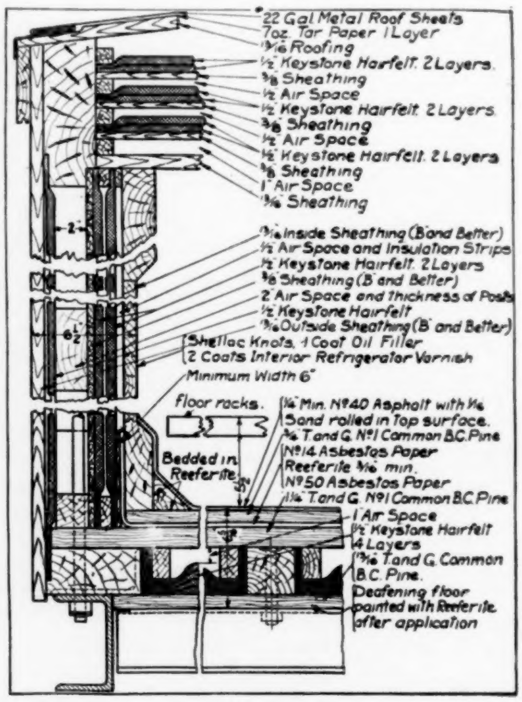


Fig. 11

Figs. 9 to 11 Types of Refrigerator Cars

Some cars are equipped with a carefully designed double-board roof with waterproofing compound between the layers. There are many advocates of this type of roof, but it is interesting to note the number of outside metal roofs that are applied to cars of this type. The advocates of the outside metal roof claim a saving in weight and greater protection to the sub-roofs and insulation from moisture, claiming that with proper insulation the metal roof has no effect on the interior temperature of the car.

Doors and Hatches.—Doors and hatches are being made with more insulation and are being strongly and properly constructed so that they will fit the door openings tightly, and not permit any loss of refrigeration due to leakage. In this connection, any other openings into the car should be so constructed that they can be kept tightly in place and easily maintained. An efficient door-locking device is no small item in keeping doors tight and thereby maintaining the efficiency of the car.

Painting.—Refrigerator cars should be kept well painted in order to preserve all exterior surfaces. This is in the interest of obtaining long life for the car. Metal parts should be given particular attention in this respect.

The author believes that refrigerator cars should be painted with a light or non-heat-absorbing color. Dark colors absorb heat. An inquiry addressed to the owners of white and yellow cars indicated that no specific data existed on the subject, but it was the general belief that the light colors were an advantage in this respect.

Insulation

It has been stated that the function of the insulation is to afford protection to the contents of the car by minimizing heat transmission through the walls, roof, and floor. A good insulator must not only be a poor conductor of heat but must be a material having the qualifications of reasonable cost, adaptibility, durability, light weight, imperviousness to moisture, freedom from odors, and be proof against vermin. In any study of insulating materials for use in railway refrigerator cars, these factors must all be kept in mind.

TABLE 2 THERMAL CONDUCTIVITY OF INSULATING MATERIALS

Material	Remarks	Thermal Conductivity [1]	Density [2]
Air	If no heat is transferred by radiation or convection	4.2	0.08
Calorax	Fluffy mineral powder	5.3	4.0
Kafok	Hollow vegetable fibers, loosely packed	5.7	0.88
Pure Wool		5.9	6.9
Pure Wool		5.9	6.3
Hair Felt	Fibers perpendicular to heat flow	5.9	17.0
Pure Wool		6.3	5.0
Slag Wool	Loosely packed	6.3	12.0
Keystone Hair	Hair felt and other fibers, confined with building paper.	6.5	19.0
Mineral Wool	Loosely packed	6.5	12.0
Corkboard	No artificial binder, low density	6.5	6.9
Mineral Wool	Fibers perpendicular to heat flow	6.9	18.0
Cotton Wool	Medium packed	7.0	5.0
Pure Wool	Very loose packing, probably air circulation through material	7.0	2.5
Insulite	Pressed wood pulp	7.1	12.0
Mineral Wool	Firmly packed	7.1	21.0
Linofelt	Vegetable fiber confined with paper, flexible and soft	7.2	11.3
Ground Cork	Less than $\frac{3}{16}$ in.	7.1	9.4
Corkboard	No artificial binder	7.3	9.9
Balsa Wood	Very light wood, across grain	7.5	7.1
Balsa Wood	Same sample with 13 per cent waterproofing compounds	8.3	8.0
Flaxlinum	Felted vegetable fibers	7.9	11.0
Fibrofelt	Felted vegetable fibers	7.9	11.0
Rock Cork	Mineral wool and binder	7.9	16.0
Balsa Wood	Across grain, untreated	8.3	7.4
Corkboard	With bituminous binder	8.4	16.0
Balsa Wood	Medium weight wood	9.2	8.8
Sawdust	Various	9.7	12.0
Air Cell ($\frac{1}{2}$-in.)	Corrugated asbestos paper, enclosing air spaces	11.0	8.8
Air Cell (1-in.)	Corrugated asbestos paper, enclosing air spaces	12.0	8.8
Asbestos Paper	Built up of thin layers	12.0	31.0
Balsa Wood	Heavy	14.0	20.0
Fire Felt Sheet	Asbestos sheet coated with cement	14.0	26.0
Fire Felt Roll	Flexible Asbestos sheet	15.0	43.0
Cypress	Across grain	16.0	29.0
Asphalt Roofing	Felt saturated with asphalt	17.0	55.0
White Pine	Across grain	19.0	32.0
Mahogany	Across grain	22.0	34.0
Oak	Across grain	24.0	38.0
Maple	Across grain	27.0	44.0
Virginia Pine	Across grain	23.0	34.0

[1] Thermal Conductivity in B.t.u. per day (24 hr.) per sq. ft. per deg. fahr. per in. thickness

[2] Density, lb. per cu. ft.

A material with low thermal conductivity, but one which is difficult to apply economically, is undesirable. On the other hand, there may be materials easy to apply but which will not stay in place or which will not retain their insulating value under service conditions; these are equally undesirable. In addition the material should be of a kind easily handled as well as easily applied.

It seems to be generally conceded that the best insulating materials are those which contain a very great number of minute dead-air cells, or interstices containing dead air. If these air cells become filled with moisture, the thermal conductivity of the material is increased. This is one of the reasons why it is so important to protect insulation from water, and why it is desirable to use a material highly resistant to moisture.

Some materials when subjected to moisture fall out of place or sag, and if a large air space, or pocket, is not formed, air circulation frequently results, the effect of which greatly decreases the efficiency of the car.

Thermal Conductivity.—The subject of heat transmission through the walls of a railway refrigerator car is one upon which there is some difference of opinion, this difference dealing largely with variables or factors which have not yet been reduced to absolute terms.

In calculating heat transmission through a compound wall it is essential to know the thermal conductivity of the various materials contained in the structure.

The most recent determinations of thermal value of various materials are shown in Table 2, taken from a paper on The Thermal Conductivity of Heat Insulators, by M. S. Van Dusen, in the October, 1920, Journal of the American Society of Heating and Ventilating Engineers.

Péclet's formula for the total heat transmission through a compound wall is

$$H = \frac{1}{\frac{1}{K_1} + \frac{D}{C} + \frac{D_1}{C_1} + \frac{D_2}{C_2} + \text{etc.} + \frac{1}{K_2}} \qquad [1]$$

in which

H = Heat transmitted per sq. ft. per hr., B.t.u.
K_1 = Inner surface conduction
K_2 = Outer surface conduction
D, D_1, D_2, etc. = Thickness of each element in wall, in.
C, C_1, C_2, etc. = Thermal conductivity (per hour) of elements corresponding to thickness D, D_1, D_2, etc., per in. thickness per sq. ft. per deg. fahr.

If the difference between inside T_1 and outside T_2 temperatures is considered, Equation [1] should be multiplied by $(T_1 - T_2)$ and becomes

$$H = \frac{T_1 - T_2}{\frac{1}{K_1} + \frac{D}{C} + \frac{D_1}{C_1} + \frac{D_2}{C_2} + \text{etc.} + \frac{1}{K_2}}$$

The thermal conductivity of each material shown in Table 2 is stated in B.t.u. per day.

In the formula, thermal conductivity C, C_1, C_2, etc., is stated in B.t.u. per hour. To be used in the formula each thermal-conductivity figure in the table must be divided by 24 to bring it to the required hourly basis. For example, Table 2 shows the thermal conductivity of white pine wood as 19.0. In this case C for white pine is $C = 19/24 = 0.790$.

Available information indicates that in the original formula $1/K_1$ was 2.0, but modern practice indicates this to be too high a value. It is felt that by assigning a value of 0.5 to $1/K_1$ refrigerator-car conditions are very nearly approximated, and this value is taken in the calculations mentioned below.

$1/K_2$ is a factor generally conceded to have a value so small that it can for all practical purposes be eliminated from the equation.

In order to illustrate the application of the formula, as well as to indicate the difference in the efficiency of walls, roofs and floors in cars of different design, calculations are given in the complete paper of the car cross-sectioned in Fig. 5, which is used as an illustration of good construction and relatively high efficiency. The car shown in Fig. 12 is used in comparison in order to show the greater rate of heat transmission or lower efficiency caused by different methods of insulation and construction. The comparative results are given in Table 3.

Materials and Workmanship

Proper materials are a very important factor in refrigerator-car construction. The right grade of lumber should be used wherever required, and it should be properly dried before being placed in the car. Workmanship should be of the best. Insulation should be handled carefully, care being taken to see that it does not become torn or damaged.

Lumber which has received preservative treatment has been given considerable attention by car builders and car owners for several years, and much of it is now in service. Sufficient time has not elapsed to indicate what increased life can be obtained, but experience to date indicates treated lumber to be more durable and a kind that will resist moisture and decay.

No objection can be made to it on account of any odor caused by treatment. In treating, the lumber is submerged for a number of hours in hot creosote oil, after which it is placed in a drip rack and permitted to drain. It is estimated that this treatment will result in large saving, doubling the life of the roofing boards and sills, and effecting considerable saving in labor that would otherwise be necessary to properly maintain these parts in the course of time.

An interesting report in connection with the use of treated lumber for use in the construction of cars was presented recently before the American Wood Preservers' Association. This report calls attention to the fact that decay is the principal cause of failures in lumber, and that great economy is possible by the use of a preservative.

It is evident that if some of the wooden parts of a refrigerator car can be made moisture-proof or highly resistant to moisture, the efficiency of the car can be maintained at a much higher average.

The author has been advised that some refrigerator cars are in service in which balsa wood is the principal insulating material. This wood is very light in weight having in its natural state a density of 7.1 lb. per cu. ft. It is a South American wood that grows very rapidly, and is of cellular structure. Table 2 shows it to have a thermal conductivity of 7.5 in its natural state and 8.3 when treated with waterproofing compounds.

It would be of great interest to know if treated or untreated balsa wood is used between the ordinary walls of a car as insulation, or if the material figures largely in the construction of the superstructure of the car, such as lining and sheathing. Its strength is insufficient for its use in framing.

TABLE 3

Comparison of B.t.u. per sq. ft. per deg. diff. fahr. per 24 hr. in cars shown in Fig. 14 and Fig. 23.

	Including Air Space		Excluding Air Space	
	Fig. 14	Fig. 23	Fig. 14	Fig. 23
Roof	1.702	2.328	1.953	3.12
Wall	2.172	2.80	2.388	3.768
Floor	2.46	2.544	2.46	3.24

It would also be of interest to know if the material is durable and efficient in this class of service, if any modification of car structure is necessary for its use, and if any reduction of car weight can be accomplished by its employment.

Other Systems of Refrigeration

In the cars described in the cross-sections and tabulation, refrigeration is accomplished by means of air circulation, the air being cooled by contact with ice or ice containers placed at the ends of the car.

One modification of this system is a car in which ice containers are placed just below the roof and in the center of the car. In this system it is claimed that maximum refrigeration can be applied where the air within the car is at its highest temperature.

There do not appear to be a great number of cars of this type in modern service. The principal objections to such a system are decreased head room in the center of the car, weight of ice near the roof of the car, and difficulty of adapting this system for use with meat racks placed below the ceiling of the car.

Another system consists of a brine tank built into the roof at each end of the car. These tanks extend about 9 in. below the ceiling and are heavily insulated on top, sides and bottom. The tanks at each end of the car are connected to each other by pipes hung about 2 or 3 in. below the ceiling. The pipes are not insulated. In each tank is a partition running lengthwise of the car. In one partition are some check valves opening to the right; in the other partition some check valves open to the left. The theory is that when ice and salt are placed in the two tanks the swaying of the car in motion automatically circulates the brine through the pipes, refrigeration being accomplished by contact of the air within the car against the surface of the pipes connecting the two tanks. Comparatively speaking, this system has not been in service a very great length of time. The advantages claimed for it are increased loading space, decreased consumption of ice, uniform temperatures, and a car that can easily be changed from a refrigerator to a heater car. The author understands that these cars are being tested in various fields of service. It would be interesting to have some information regarding the ability of this system to supply refrigeration when the car is not in motion, and what the system can accomplish in the way of quick precooling when the car is placed at the loading shed or platform.

The interior of such a car is shown in Fig. 4. This illustration shows the floor racks propped up against the side walls so that the piping along the floor beneath the racks can be seen. This piping is used when the system is used to heat the contents of the car. Canvas troughs are placed beneath the piping located beneath the ceiling in order to catch any condensation or frost slush that may drop from these pipes.

Precooling

The importance of precooling the lading and the resulting economy in the use of ice and labor were mentioned in a preceding paragraph. There are two distinct methods of precooling cars and lading. The first is known as shippers' precooling; and the lading is placed in cold-storage rooms in which the proper temperature is maintained, and where the lading is allowed to remain until it cools to the proper temperature, after which it is loaded quickly into cars that have been pre-iced. The second method is known as the carrier's precooling, and generally consists of a system in which the car is loaded, after which the interior of the car and the lading are precooled by mechanical means. In one system of this kind, at a point where a large tonnage of citrus fruit originates, cars are placed at a precooling dock where the ventilator hatches are connected with large air pipes, and the lading is precooled by means of a forced circulation of cold air. The air is brought to a low temperature in the cooling rooms of the plant, and passes through a long concrete tunnel and into a pipe connected to the hatchway at one end of the car. The air passes through the entire length of the car and out through another pipe connected to the hatchway at the opposite end of the car, and thence back to the cooling room through another concrete tunnel. The cold air passes through the car at a rate of 6000 ft. per min. at a temperature ranging from 12 to 20 deg., for a period of 30 min., after which the pipes on the hatchways are reversed and the cold air is forced through from the opposite end of the car. These pipes are reversed every 30 min. for a period of 4 hr. when the process of precooling is complete. It is stated that citrus fruit loaded into the cars at temperatures of from 80 to 90 deg. can be brought down to 45 deg. within this time. After the car is cooled in this manner it is iced to capacity.

Recently a very interesting and large precooling plant has been erected in the vegetable section at Sanford, Florida, and is operated by the shippers. From this section large shipments of celery are made from January until June. After a careful analysis of the desirable points of an efficient precooling plant, the shippers at this point decided to branch into an entirely new field by adopting a novel method of removing the heat from the celery. This consists of causing a large volume of cooled water to flow over the celery. The average temperature of the water used in this plant is approximately 35 deg. fahr., and it has been stated that the temperature of celery can be brought down from 75 deg. to within 2 deg. of the temperature of the water within 20 min. This plant has a cooling capacity of approximately 15 cars per 24 hours.

Another system of precooling involves the freezing of the lading and a precooling of the car by means of a brine-spray system. When commodities can be frozen hard and shipped in a precooled car, refrigeration may be entirely accomplished or helped to a very great extent by the frozen lading.

Great economies are possible due to precooling. Where small tonnage originates little precooling has been done by mechanical methods on account of the high cost of the plant and equipment. Most mechanical precooling is done where large tonnage originates. At such points the shippers frequently combine to build such a plant. Precooling is receiving more and more attention in connection with various commodities and additional economy in the way of ice and labor may be expected.

General Conclusion

The inquiries upon which these few notes on railway refrigerator cars are based indicate that a very great improvement has been made in refrigerator-car construction and design, particularly within the last few years, but there is also evident indication that the field of investigation in connection with cars of this type is still a most fertile one. Some fairly recent cars indicate that subject of refrigeration in transit is not appreciated in some quarters as it should be. The subject of efficient refrigeration is a most important one, because cars that can be kept in continuous service with a minimum cost of maintenance and which are sufficiently efficient to protect the lading in transit, mean dollars and cents to the railways.

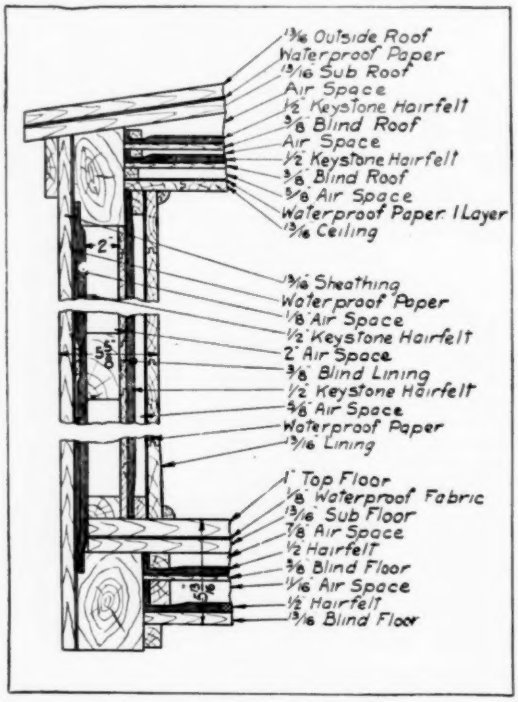


Fig. 12

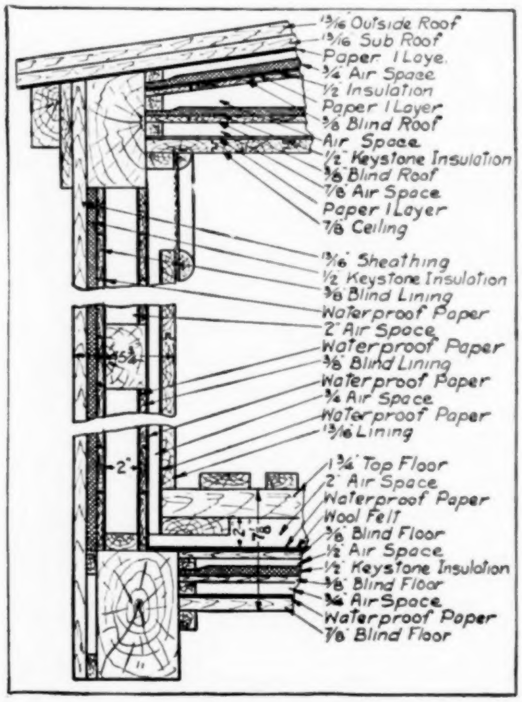


Fig. 13

Figs. 12 and 13 Types of Refrigerator Cars

The Accuracy of Boiler Tests

By ALFRED COTTON,[1] ST. LOUIS, MO.

This paper points out the unavoidable inaccuracies involved in reports of boiler tests and the absurdity of assigning values carried out to the one-hundredth of one per cent to items which cannot possibly be measured so closely.

The various factors which enter into boiler-test computations are taken up one by one and errors which may be made are covered and the best methods of reducing them considered.

The most important elements are of course the determinations of water and coal used, and of steam produced, both as to quality and quantity. It is shown how the error in obtaining the B.t.u. in the coal burned may easily reach 2.5 per cent in either direction, the water evaporated may be at least one per cent out of the way, and hence the efficiency reported may be 3.5 per cent too high or low.

A LARGE proportion of boiler-test reports are presented with heat-balance figures carried to one-tenth and even one-hundredth of one per cent. Those who have had much experience in boiler testing know that such apparent accuracy is impossible at present and therefore misleading. In a heat balance recently published the percentage portion does not add to an even hundred. Since the last item is simply the difference between what is known and 100, why not make it agree? The deviation from 100 makes it appear that the items are very precise indeed.

How accurate is it possible to make a boiler test? To determine this, every item entering into it must be considered.

First consider the measurement of the water. If the water is carefully weighed or measured by suitable meters the amount fed may be ascertained well within plus or minus 1 per cent. If meters are used, they may be calibrated before the test, and perhaps afterward as well, to insure this accuracy. Proper precautions may be taken to prevent leaks from blow-off cocks, in feedwater heaters, and so forth. Care can also be taken to see that the condition of the water in the gage connections is the same at the end as at the beginning of the test. If this is not done, error may be introduced to the extent of 1 or 2 in. due to the difference in the weight of cold water in the gage connections before blowing off, and of hot water afterward. With an eight-hour test run at rating, the error may be more than 1 per cent from this cause.

Quality of Steam—Steam Sampling

Then there is the quality of the steam to be accounted for. The entrained water in the sample can be ascertained very closely, but it is sometimes stated with much greater precision than the observations warrant, or than is necessary. A boiler-test report was seen recently wherein the proportion of water in the steam was given to one-ten thousandth of one per cent!

The temperature of the steam in the expansion chamber of a throttling calorimeter need only be read to the nearest degree; and when averaging the readings, the result need not be expressed beyond one-tenth of a degree. A glance at a steam table will show that the variation is so slight that carrying it further is futile.

But does the sample of steam so examined represent the bulk steam? That is something which is not known, and the more elaborate discussion given in the complete paper seems to show that it is *not even nearly representative.*

The design and position of the sampling tube are matters of some contention. It is accepted practice to perforate the sampling tube and place it horizontally across the pipe. It is probable that entrained water is commonly in such small particles that it is easily carried in suspension at usual steam velocities. Water flowing along the bottom of the pipe is likely to be mostly condensed steam, and is therefore rightly avoided by placing the sampling pipe horizontally.

The A.S.M.E. sampling tube is made of $^1/_2$-in. standard pipe and is provided with twenty $^1/_8$-in. holes arranged in "irregular or spiral rows," and usually in a more or less regular helix. It should be inserted in the steam main "at a point where the entrained moisture is likely to be most thoroughly mixed." The word "likely" is highly commendable.

It is most probable that the design of a steam-sampling device should be somewhat similar to that of a rain gage; and if this is the case, the A.S.M.E. tube is as unsuitable for its purpose as anything which could well be contrived. One of the fundamental requirements in the location of a rain gage is to avoid the proximity of objects which might shelter the instrument or cause eddies. This requirement is ludicrously violated by the downstream holes in this steam-sampling tube. It would appear that the best position for the holes is directly upstream, and that all holes should be in a line facing in that direction instead of being distributed around the tube. For the smaller steam pipes, a smaller number of large holes could be used, placing them at least, say, 3 diameters center to center, and making their total area about equal to the twenty $^1/_8$-in. holes or, say, 0.25 sq. in.

The most accurate results would be attained with such upstream holes if the velocity of the steam entering the holes approximated that of the bulk flow along the steam pipe. Then the steam and water particles would enter the holes with the least disturbance of their general direction, and consequently the sample would be most representative.

It seems reasonable to think that the actual water present in the steam may be very much less than that observed when we use the A.S.M.E. tube.

If there is much priming, the error in determining the amount of water carried over may approach plus or minus 5 per cent of that evaporated. But assuming orderly operation and careful observation, the accuracy of the report on water evaporated may be from plus or minus 1.5 to 2 per cent; but it cannot well be guaranteed to be closer.

Estimating Coal Consumption

The next item to be considered is the coal, and this may easily be weighed well within plus or minus 1 per cent. However, this is but the coal fed to the furnace, and to know the quantity actually burned in relation to the water evaporated, we must be sure that there is the same amount of fuel in the furnace and in the same stage of combustion at the end of the trial as at the start. The only way to find this out is to look at it. Only those who have done this know how impossible it is to accomplish much more than make a careful guess, and it must be done quickly because conditions are changing momentarily. It is not uncommon for different observers to vary in their estimates to the extent of 10 or even 20 lb. of coal per sq. ft. of grate area. In a test during which a total of 250 lb. of coal was burned on each square foot of grate, the error from this source might amount to over 5 per cent. The error will depend on the length of the test, and for 12-hour tests may very reasonably be placed at not less than plus or minus 1 per cent.

Coal Sampling and Analysis

But, unfortunately, this coal weight does not mean anything of itself. We must at least know the weight of *dry* coal; and if the moisture present in the coal is much over 2 per cent, allowance should be made for the heat used to evaporate and superheat it. To find out how much moisture there is in the coal, we must have a representative sample, and then we must analyze it for moisture *while it is representative.* While working down a laboratory sample the coal will either gain or lose moisture. In a warm, drafty room and especially on a warm floor, it will generally lose moisture, perhaps as much as the equivalent of 3 per cent of the coal or even more. While it is properly bottled up, no further change will occur; but at the laboratory, while being finely ground and while weighing samples, further change will undoubtedly occur and this may be either in increase or reduction of moisture. During all these processes of sampling from the coal pile to the laboratory

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Abridgment of paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

drying oven it does not seem possible to certify the moisture closer than plus or minus 1 per cent, and it may easily be out plus or minus 2 per cent. Taking the alternative method of drying the coal during the test, there is the difficulty of securing a representative sample, for we are now sampling coal which has not been weighed to the firing floor or hoppers; and there is also the further difficulty of crude drying and weighing apparatus. However, this method is likely to be a little more accurate than the orthodox one, and with reasonable care in selecting samples, results may be obtained within plus or minus 1 per cent.

On examining the report of any boiler trial, the first thing looked for is the efficiency at the trial load. Without this, the report does not generally convey information of very much value. To get the efficiency we must know the heating value of the coal; and whether the heating value is found by calculation from the analysis or by the calorimeter, the essential feature is the extent to which the sample is representative. To fully satisfy this requirement it should have come from widely distributed points in the original bulk coal used during the trial. Of course, this condition is very far from being reached even with the orthodox method of quartering down, unless the test is with powdered coal. Still, such a sample is reasonably representative if the work of getting it has been conscientiously done.

Summary of Errors

It is well here to summarize the possible errors and see where they may lead, and this has been done in the following tabulation, keeping them even lower than suggested.

	Error
Coal:	
Weighing	± 0.5 per cent
Estimating amount of fuel in furnace at start and stop	± 0.5 per cent
Total error of weighed coal	± 1.0 per cent
Variation between original percentage of moisture and that in laboratory sample plus failure of sample to truly represent bulk	± 1.0 per cent
Failure of heat-value sample to represent bulk	± 0.5 per cent
Total error in analysis	± 1.5 per cent
Total error in B.t.u. in coal (weight and analysis) on which efficiency is based	± 2.5 per cent
Water:	
Weighing or metering, starting and stopping test, gage glass, leaks	± 0.5 per cent
Failure of sample of steam to truly represent bulk steam as to entrained water	± 0.5 per cent
Total error in water evaporated	± 1.0 per cent

B.t.u. in coal burned may vary 97.5 to 102.5 per cent.
Water evaporated may vary from 99.0 to 101.0 per cent.
Reported efficiency may vary from 99.0/102.5 to 101.0/97.5, or 96.6 to 103.6.

Therefore if the efficiency really attained in any boiler trial is 78 per cent, the report may show as low as 75.4 per cent or as high as 80.8 per cent if all the errors happen to be in one direction. It may be thought that this possible error is placed at a higher figure than occurs in practice; but it must be remembered that generally the errors will be in different directions and so tend to neutralize each other, and it will be seldom that they are all one way. Consequently if a sufficiently large number of trials are made on the same boiler under the same conditions, some of the tests will nearly always be found to deviate from the average quite as much as the total possible error here suggested.

If the coal and water deductions are relied on, we know the efficiency and the load. But in view of what has been said it is very doubtful if the regular carefully conducted boiler test burning hand- or stoker-fired coal can be guaranteed to be closer than within plus or minus 3 per cent.

The Heat Balance

The heat balance is often considered as a final check on the correctness of the test. A boiler-test report without a heat balance is just as good as the other kind as far as efficiency at load is concerned. But the heat balance confers dignity and precision on the test report because all the items add up to 100 and this seems to prove the correctness of everything concerned in it. However, since it does not "balance" or rather that we *make* it balance, the term "heat balance" is not without humor. If accountants submitted items in their balance sheets called "unaccounted for" amounting to $5 in every hundred dollars there would be considerable unpleasantness. Of course, a heat balance is different because there is the excuse that no way has been discovered to find out the amounts of some of the items and the others are not as accurate as is generally believed. There is a case of four consecutive tests made on the same boiler by an engineering professor of deserved repute and large boiler-testing experience, in which the "unaccounted for" was respectively 8.7, 0.4, 6.4, and 7.4 per cent. The trials run by Dr. Jacobus on the Delray boilers were among the most careful ever made, and the "unaccounted for" item runs from 1.51 to 4.83—a difference of over 3 per cent. Incidentally, the efficiencies in the series of tests vary over plus or minus 1 per cent from their average rating-efficiency curve.

The real value of a heat balance lies in the presentation of the various losses and their amounts, and therefore it is more a *statement* than a *balance*.

Care has to be taken to get an average sample of flue gas. Its composition sometimes varies greatly across the width of the setting—as much as 5 per cent of CO_2 according to some experiments, though perhaps some of this variation was caused by the quality of the gases changing rapidly between taking samples. It seems likely that if the gas sample is drawn from some point well within the gas flow, it is fairly representative, for if that were not so, the "unaccounted for" would show a still larger variation than it actually does. This also applies to exit gas temperature, where the radiation effect may affect the readings 50 deg. fahr. With care in placing the instruments the error is perhaps within plus or minus 20 deg. fahr., or about plus or minus 1 in the percentage of heat loss to the stack.

Efficiencies

Even the efficiency as now reported does not provide a proper basis for making comparison between different trials under different conditions. An efficiency of 75 per cent with a steam pressure of 225 lb. is a better performance than the same efficiency at 75 lb. pressure. To be serviceable for comparison, the efficiency should be based on what is theoretically possible in each individual case, and this is governed by the temperature of what is being heated and not by the temperature of the atmosphere.

At first sight it appears that it is not theoretically possible to get the exit gas temperature below that of the boiling point. Therefore the efficiency should be based on perfect combustion with the theoretical amount of air and the products of combustion cooled to the boiling point for the existing pressure. This is not very difficult, and the 100 per cent figure would be set for the particular fuel and steam pressure under consideration. The efficiency would be the percentage of the figure attained on the test and might be called the "actual" efficiency to distinguish it from the efficiency as now reported, which might be called the "theoretical" efficiency.

Whether the mean temperature of the water in the boiler or that at the gas exit should be used, is another consideration. In a horizontal water-tube boiler, for instance, the lowest tubes may be 15 ft. below the water level. The added pressure due to this head of water is 6 lb., making a total pressure of 156 lb. when the gage pressure is 150 lb. This increases the boiling point 3 deg., and either the water is hotter at the bottom of the boiler or no steam is made there.

The temperature to be used is really dependent upon the extent to which the cold feedwater is segregated. The boiling point may be considered as the proper temperature to use with a boiler in which the feed is so mixed with the circulation that no cold water comes in contact with the heating surface, while with a separate economizer or a flash boiler the temperature of the feedwater should be adopted. But difficulties at once arise with boilers where there is partial segregation. In boilers having integral economizers the feedwater may be wholly or partly segregated. In integral economizers of the Badenhausen type, for instance, there is considerable circulation within the economizer, and the temperature of the water where the gases leave will certainly be

well above that of the entering water. A somewhat similar condition obtains in the rear bank of the Stirling boiler, which is, or used to be, often called the "economizer bank."

It appears, then, that the design of boiler must be taken into consideration and the temperature chosen be that of the boiling point, or of the cold feedwater, or somewhere between these points according to the extent of segregation of the incoming feed. A chart like Fig. 1 could be used and a position on the curve agreed upon for every type of boiler, such as the following:

Position	Type of Boiler
A	Horizontal water-tube
	Scotch marine
	Horizontal return tubular
B	Stirling with rear circulators
C	Stirling without rear circulators
D	Boilers with integral economizers having free circulation
E	Boilers with integral economizers having restricted circulation
F	Boilers with separate economizers
	Flash boilers.

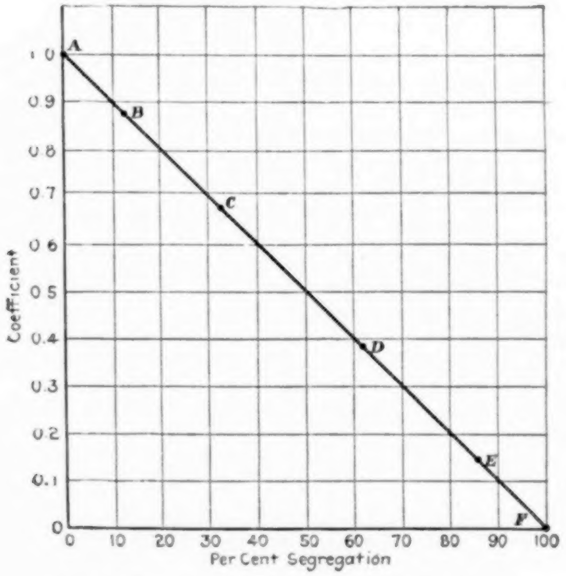

Fig. 1 Effect of Segregation of Feedwater

It is not intended to propose that the positions thus suggested by way of illustration be accepted, either absolutely or relatively. But as an example, with a boiler having 25 per cent segregation, the coefficient as read from the chart is 0.75. Suppose the boiling point is 370 deg. and the feedwater enters at 130 deg., then the difference is 240 deg. and 0.75 of this is 180 deg. Then $180 + 130 = 310$ deg. fahr., which is the temperature to be used.

It might be advisable to make some kind of an allowance for the rate of driving, because this would have some effect on the temperature to be used in those boilers having partial segregation of the feedwater.

Probably the simplest way to dispose of the matter is to take the temperature of the water in the boiler at the point where the gases leave, making regular observations during the test. In this way there would be no contention whatever as to the proper temperature to use. The average of these observations would be recorded in the test report.

The efficiency based on the temperature of the water in the boiler is the only efficiency by which different boiler performances may be intelligently compared. But it must be remembered that the limit of temperature on which it is based is artificially imposed. It may be considerably lowered by the installation of an economizer, and perhaps still more so by apparatus yet to be devised or more generally adopted. When an economizer is added it may be that the efficiency—which will now be based on the feedwater temperature—is lower than before. Of course, this is quite proper because this is really the actual efficiency of the apparatus as a heat generator and absorber. But for the comparison of one steam plant with another or for changes in the circumstances of the same plant such as the addition of the economizer, the efficiency based on the heat value of the coal must be used. Therefore it appears highly necessary that both of these efficiencies be reported in every test. These efficiencies may be stated as:

$$\frac{\text{B.t.u. in steam}}{\text{B.t.u. in dry coal}} = \text{Theoretical Boiler and Furnace Efficiency}$$

$$\frac{\text{B.t.u. in steam}}{\text{B.t.u. available}} = \text{Actual Boiler and Furnace Efficiency.}$$

All comparisons of efficiency are properly based on the load in percentage of the boiler rating. When a superheater forms an integral part of the boiler, the heating surface is greatly increased. The efficiency is greater owing to the increased heating surface reducing the temperature of the escaping gases. But still the efficiency is plotted against boiler rating, in other words, against boiler heating surface only. This is wrong. The combination should be rated at some higher horsepower than that of the boiler only. It would be a very difficult matter to decide how much to allow for superheating surface as its heat-transfer rate is quite different from that of boiler heating surface. But superheating surface should be rated as the equivalent of so much boiler heating surface.

The same thing applies to economizers. What is the proper way to report a boiler test where there is an economizer? I quote from a test report case of unquestionable authority:

Water-heating surface	4400 sq. ft.
Builder's rating	440 hp.
Economizer heating surface	6290 sq. ft.
Hp. developed for boiler	1231
Hp. developed for boiler and economizer	1350
Percentage of rating developed for boiler	277
Percentage of rating developed for boiler and economizer	305

What is the meaning of the last item? The one above it is the regular statement of percentage of rating. But the boiler did not develop more horsepower or a higher percentage of rating because there was an economizer near it. The economizer did this extra work—not the boiler. What percentage of the *rating of the economizer* did the economizer develop?

The steam, or its equivalent when electric motors are used, consumed in driving stokers and mechanical-draft apparatus should always be ascertained and reported as a percentage so that it may easily be deducted from the efficiency by any one sufficiently interested. In testing all or most other apparatus, the efficiency is output divided by input; but in boiler testing we do not know yet how to accurately measure the output. We weigh the water going in and boldly state it as output. Surely the available steam sent away from the boiler is the real output, and if so, all steam used to make the boiler and its accessories work should be allowed for. As conscientious engineers we have always strictly seen to it—and shall continue to do so—that such things as internal-combustion engines, hot-air engines and the like shall be tested with a brake so that we know exactly what is their actual output; and the more power they consume in making themselves work, the worse for them. But we seem to prefer to avoid telling any one what the real output of a boiler is.

Economizers raise the efficiency by lowering the flue-gas temperature, and they sometimes do this to a point where the gas temperature is too low to produce sufficient chimney draft, in addition to increasing the draft resistance. So an induced-draft fan is used, but the power taken to drive it is rarely considered.

The following very imposing array of data is sometimes presented:

Water evaporated, actual, per lb. of coal as fired
Water evaporated, actual, per lb. of dry coal
Water evaporated, from and at 212 deg., per lb. of coal as fired
Water evaporated, from and at 212 deg., per lb. of dry coal
Water evaporated, from and at 212 deg., per lb. of combustible.

These items are sometimes carried to one-thousandth of a pound and none of them means anything. Any kind of evaporation per pound of coal in any condition is without meaning unless the heating value of the coal is known, and knowing this the efficiency, which is what is desired, can be easily determined.

In *The Engineer* (London) of February 25, 1921, H. V. Whittaker suggests basing the evaporation on "standard coal" and he further suggests giving this theoretical coal a value of 12,600 B.t.u. If all tests were reported on the basis of this standard coal we would

have a definite standard for the comparison of different performances. But why not go a step further and drop the meaningless evaporation per pound of coal altogether and report the result as B.t.u. in the steam per 100 B.t.u. in the coal? This figure is the efficiency without further ado. There is nothing difficult about it. In calculating the test, the B.t.u. in one pound of liquid is subtracted from the B.t.u. in one pound of steam, superheated or otherwise, and multiplied by the weight of water evaporated. The "factor of evaporation" disappears, and the correction for moisture in the steam is just as easy. The B.t.u. per pound of coal is multiplied by the coal weight and divided into the B.t.u. taken up by the steam. The quotient is readily expressed as B.t.u. in the steam per 100 B.t.u. in the coal. The B.t.u. per hour taken up by the steam is easily converted into the obsolescent "boiler horsepower."

The object of all boiler tests is comparison either with some other test or group of tests or with our general experience, which is the same thing. The report should therefore contain everything which will show the relative arduousness of the conditions under which the test was made, including the variation in load.

Tolerances

In all manufacturing operations it is realized that nothing can be made absolutely correct. Therefore tolerances are allowed. Whether the suggested plus or minus 3 per cent for boiler trials is considered too large or not, the fact remains that the performance of guarantees is demanded without any tolerance whatever. It is said that if guarantees should carry a tolerance of, say, minus 2 per cent, manufacturers would raise their guarantees by 2 per cent, relying on this margin. If all manufacturers followed this policy they would be on an equal footing and no commercial harm would be done. As matters stand now, however, the prudent manufacturer virtually sets his own tolerance by guaranteeing something less than he knows he can accomplish; while if the proposed tolerance is adopted he can guarantee all he knows he can do, and let the tolerance take care of the testing errors.

There is nothing whatever to be gained by reporting efficiency more closely than the nearest tenth of one per cent, or even the nearest half. Not only is such apparent precision as 1 in 1000 unwarranted by the exigencies of boiler testing; but engineering judgment is quite unable to make use of it. It is mentally impossible to differentiate between the relative values of 79.9 and 80.1 per cent efficiency and it seems only sensible to call it 80 per cent. Especially is such overprecision absurd, inasmuch as it is not certain that it was not really 79 or 81 per cent, or even a little further away.

Discussion On Accuracy Of Boiler Tests

The discussion of Mr. Cotton's paper was opened by Grant D. Bradshaw[1] who emphasized the author's contention that unavoidable errors creep into a boiler test which, in the aggregate, amount to a considerable figure if they do not compensate one another. That it is doubtful if the accuracy of a boiler test can be guaranteed closer than within plus or minus 3 per cent, he said, was substantiated by Dr. Jacobus' tests on the Delray boilers, where the unaccounted-for item was from 1.51 to 4.83 per cent. This gives to the figure for radiation and unaccounted-for losses a considerable importance when judging the probable value of results. The problem of sampling steam for the determination of its moisture content, he said, was closely allied in principle to that of collecting a gas sample, where differences in the velocity of gas in the steam and in the collecting tube could not be allowed without error.

Henry Kreisinger[2] wrote that errors in making boiler tests were frequently as large as the author gave them, and in some cases even larger. Only by making several trials of 24 hours or longer at the same rating could dependable results be obtained, he said. He discussed some of the sources of error, such as those in measuring the weight of water evaporated, determination of temperature of superheated steam, the collection and preparation of the coal sample, and gave some comparative figures of coal analyses made at different laboratories from the same sample.

[1] Pres., Andrews-Bradshaw Co., Pittsburgh, Pa. Mem. Am.Soc.M.E.
[2] Majestic Bldg., Milwaukee, Wis.

The heat balance, he wrote, if accurately computed, is perhaps the most valuable part of a boiler-test report as it shows what the principle losses are and indicates the accuracy of the test. He agreed with the author in the matter of reporting boiler-test results directly in B.t.u. absorbed per pound of coal, or in B.t.u. absorbed per 100 B.t.u. in the coal, and favored dropping the terms "equivalent evaporation" and "factor of evaporation."

W. A. Carter[3] read a discussion which he had prepared in collaboration with C. F. Hirshfeld,[4] C. Harold Berry[5] and Paul W. Thompson.[6] These engineers made a distinction between commercial and research tests, and thought that the probable errors cited by the author were considerably larger than were justified by experience in reasonably careful commercial testing. Treating tests from the research point of view, they discussed the limitations of accuracy which their experience had taught them to expect. They maintained that overall efficiency as now computed expressed fully the accomplishment of the combination of boiler, furnace and grate, and for strictly commercial testing no other result was desired.

I. E. Moultrop[7] wrote that the degree of reliance which can be safely placed upon the results of a boiler test depends on a knowledge of the conditions under which the test was made, and that the value of the results of the test depends upon the experience of the men who conducted it. He commented on a number of subjects, such as steam sampling, determination of coal consumption, the term "actual efficiency" used by the author, and tolerance.

G. C. Vennum[8] wrote that the heat balance of a boiler test was the best medium for judging the accuracy of the report, and for drawing conclusions as to characteristics of performance. He did not believe that the schedule for reckoning the performance of different boilers under various conditions, as proposed by the author, would offer a good basis for comparison. What was wanted was a knowledge of the relation between the energy in the fuel and the energy available in the steam. Boiler design, feedwater temperature, steam pressure and superheat are all factors in the result, he said, and cannot be adjusted to give a true statement of efficiency.

E. H. Tenney,[9] while agreeing that the possibilities of error in conducting a boiler test are within the limits of accuracy, wrote that the author had not pointed out a method for the elimination of such error. Experience has proved, he said, that a boiler test conducted by reputable engineers, in accordance with the present standards laid down by The American Society of Mechanical Engineers, gives results which can be relied upon and which are accurate for comparison with other trials and conditions. He made a point of the necessity of extending the period of the test over 24 hours, or more, and that a heat balance serves as a check on the reported results.

John E. Bell,[10] in acknowledging the truth of the author's statements about the errors in reporting boiler trials, expressed the opinion that very few boiler tests have been made in this country that are accepted unreservedly. He wrote of the difficulty of sampling coal and of determining a satisfactory analysis and heat value. Importance can be attached only to a long series of tests each of at least 24 hours' duration, checked by duplicate tests, he said, and even such tests are worthless unless every effort has been made to attain the highest efficiency and to eliminate all sources of error. The heat balance is used to determine the importance to attach to such tests. He agreed with the author as to the absurdity of carrying results to an unnecessary number of decimal places.

(Continued on page 437)

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Economics of Water-Power Development

Discussion of Production, Maintenance and Selling Costs and Fixed Charges—Many Business Hazards and Sometimes Enormous Unrecoverable Losses

By CURTIS A. MEES,[1] CHARLOTTE, N. C.

ECONOMICS as applied to this particular subject relates to the planning and administration of hydroelectric plants in a manner such as to avoid wastefulness and extravagance.

The question of water-power development as a paying proposition, however, is another matter, and since each of these concepts covers a very wide field, it seems preferable at this time to touch, in a very general way only, on the essential factors pertaining to both problems in such a manner as to elicit profitable discussion thereon.

Only in very rare instances is it practicable to depend on water alone for the production of power for commercial purposes, and auxiliary power sources are therefore presumed to be a necessity and their construction and operation is herein considered as concomitant to water-power development.

The power business is akin to that of manufacture, as this term is usually conceived, and the conduct of this business is in many respects successful or unsuccessful in that measure in which the precepts for efficient and profitable manufacture are observed.

In other respects special problems are presented because the product after manufacture must be sold and delivered to the consumer, for instantaneous use in a circumscribed market; and while the selling cost is dependent entirely on the immediate operation of the law of supply and demand, the selling price is generally fixed by regulation.

Just as this is true of any manufacturing enterprise, the success of a power development depends not alone on the perfection of the Physical Structure, i.e., the mechanical equipment, and the Production Structure represented by the operating personnel, but in even greater measure on the efficient functioning of the Commercial Structure and the adequacy and flexibility of the Financial Structure. Many monumental developments are, by the well informed, known to be failures.

It should be readily appreciated, therefore, that in any abstract discussion such as this it is impracticable to attempt anything beyond merely setting forth various items that particularly require consideration in an analysis of the commercial features of a power development, and pointing out in general terms their effect on net earnings, or the margin between selling cost and selling price.

Factors of Selling Costs

Selling cost is made up of raw-material cost, fabrication cost and delivery cost. In each of these costs we have both variable elements subject to fluctuation with quantity production and susceptible to modification, and fixed elements which are not affected by applied economics, once the physical structure has been completed.

To each of these classified accounts there must of course be disbursed, either directly or in proper proportion, managerial supervision, clerical expense, cost of tests and experimental research, and a multiplicity of similar charges which occur in all manufacturing business and involve no peculiar features.

The raw-material cost may be determined by any or all of the following items: rental of water; land and water rights for reservoir; conditioning of reservoir; hydraulic control works; fuel delivered to plant; fuel-handling and storage facilities.

In establishing the feasibility of a development in view of these items, it should be noted that the unit cost of fuel is indeterminate unless quality is fixed by specification. The cost of fuel itself fluctuates with the market, generally in such a manner as to affect all competitors alike. Loss or deterioration in storage is a variable applying equally to fuel or water in a reservoir, and for water as well as fuel the unit cost is indeterminate unless quality and quantity are fixed by specification.

The cost of overflowed lands determines a fixed charge but the useful volume of water available and the effective head at which it may be used are variables, the proper determination of which constitutes the most difficult task involved in power-plant engineering and without the determination of which no unit is established for distribution of the cost.

Curiously enough, the requirements, of purchasers of the product of this factory have a decided influence on the unit cost of the raw material, because while water may momentarily be available, its non-use at that particular moment may result in its utter loss. Prevention of such loss, to the greatest possible extent, is of course an extremely important consideration in the planning of details of the development.

The cost of structures such as dams, gates, pipe lines, coal crushers, oil tanks, etc., determines fixed charges for water or fuel. Operation and maintenance of these structures are variables, and in planning them the engineer may choose whether fixed charges or the variables shall be increased or decreased. For instance, on the one hand a reservoir may be carefully cleared and the expense of so doing becomes a capital cost, or on the other hand only little clearing may be done and floating débris must then be removed from the racks from time to time. This expense then becomes an operating cost.

Fabrication Cost

Of the three cost elements, fabrication is least affected by fortuitous circumstances. In a broad sense this cost is made up of fixed charges growing out of the capital cost of erected power-generating equipment, suitably provided with necessary or desirable adjuncts, housed or located outdoors as the case might be, and of operating charges which include wages, supplies, repair parts, etc. Capital cost of the plant may, however, and quite properly so, lie between wide limits for the same output of product, depending on two totally distinct provisions: uniformity of stream flow and character of service requirements, both as to continuity and uniformity.

It must be borne in mind that the manufactured product is kilowatt-hours, that the time element is just as important as the capacity element and that, in general, a sale is consummated only when capacity is available at the instant of use and for the period of use. Thus the hours of use for any given market must be most carefully predetermined for the proper selection of prime movers, and beyond this capacity must also be provided equivalent to the maximum instantaneous demand for current, else the product will not be salable.

It is readily apparent, therefore, that, in general, only one-half as much generating equipment is necessary for a 24-hour load as for a 12-hour load and that for a 24-hour load only one-half as much equipment is required to produce a perfectly uniform output as for a demand which fluctuates from zero to double the average load.

Capacity for the water-power plant having been fixed by the character of the load, there follows the determination of proper capacity for the auxiliary plant.

While this choice may possibly be dependent on a volume of output imperatively continuous, it is much more likely that it will hinge on meteorological criteria. One need only to mention that, in the first place, the run-off from any drainage area or the discharge of a stream fluctuates between very small quantities at times of drought and quantities sometimes many thousand times greater when in flood with, in general, little regularity about the occurence of either stage, and that, in the second place, the average usable discharge for some years is considerably lower than for others.

Natural stream flow is determined either by measured discharge or by computed run-off based on recorded rainfall. From these data there is estimated the average annual stream flow and these determinations will approach correct values according to the length

[1] Mees & Mees. Mem. Am.Soc.M.E.

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of the period of observations considered. These findings should be modified by an accuracy factor.

Depending on the topography of the development site, either at the power plant or on the drainage area above it, storage capacity may be created of such extent as to afford either daily or seasonal regulation. By daily or weekly regulation is meant the conservation of natural stream flow during either 24 hours or 7 days for use during those hours only when load can be sold. By seasonal regulation is meant the controlled, artificial increase of natural stream flow out of waters stored during periods of run-off in excess of the usable quantity.

Regulated stream flow having been estimated for each year and for the average of all years of record, it will be found that, when daily discharges are plotted as shown on Fig. 1, one can very readily forecast what power output is continuous and what additional output may be sold for any predetermined portion of the year, as this is fixed by low-water stages.

For high-water stages, while there will be an excess of water available, it frequently happens that loss of head results from this cause

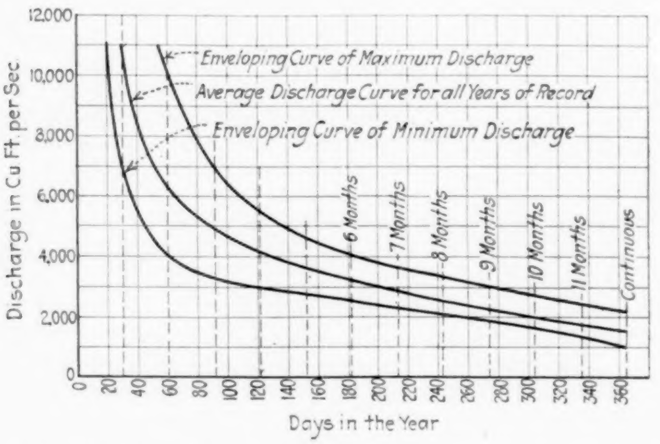

Fig. 1 Stream Flow During Various Portions of the Year

and in that event restriction of output must be determined similarly as for low-water stages.

Only in exceptional cases is it commercially practicable to develop a water-power plant for an output based on absolute minimum stream flow, and it is therefore customary to base earnings on that output which may be produced in the average year.

The equipment of the auxiliary plant is then primarily fixed by that capacity which may be necessary to supplement the water output of the lowest year to bring it up to that of the average year. Beyond this, except for possible emergency capacity, it becomes a question of dollars and cents, based on salability of secondary power and rates which may be secured for this service, as to the extent to which one can afford to install auxiliary equipment for the conversion of short-term water output into continuous combined water and auxiliary output.

Dependent on local conditions, the capacity which must be installed for emergency service might finally be the determining factor in equipment selection. It may happen that in flood a water-power plant may be completely incapacitated through loss of head so great as to make impossible the maintenance of synchronous speed. Ice blocks also might completely prevent operation of a plant. For such cases, under certain load conditions it might become imperative to provide 100 per cent stand-by capacity.

Legitimate capital cost and resulting fixed charges must therefore be most carefully determined for each individual project and comparative figures are not necessarily indicative of their propriety.

Another so-called fixed charge is quite beyond control and that is taxes. Cost of supplies and repair parts are regulated by the law of supply and demand and cost of labor may or may not be determined similarly according to the extent to which organized labor can enforce its dicta as to rules and rates.

One phase of control as to fabrication cost is of particular importance in this business and that is the continuous, most efficient conversion of raw material into the finished product. This is not a question of workmanship but rather one of intelligent direction. Loss in kilowatt-hours produced out of available water and per unit of fuel may, under improper allocation of part loads to various equipment items, be considerable and difficult of detection.

Delivery Cost

Delivery of power may be effected either direct to the ultimate consumer or at wholesale to a distributor and the cost of delivery depends very largely on the method in vogue or proposed, but the greater cost of retail service is offset by a rate differential such that in the end earnings on the unit of investment are not, in general, materially affected by the adoption of one rather than the other of these plans.

A transmission system may be considered to be composed of trunk lines, secondary lines and feeders. The cost of trunk lines depends primarily on the proximity of the power plants, principal and auxiliary, to each other and to the center of load, whereas the cost of secondary lines and feeders depends largely on quantity requirements, both as to capacity and period of use, or what is synonymous, the number of consumers served and the density of the market.

Secondarily the cost of transmission lines is affected by the relative importance of assured continuity of service and in addition the locality variable enters into the problem. Urban work, values of land, size of properties crossed and similar circumstances greatly affect the cost of lines. The rigors of climate, cyclones and the prevalence of electrical disturbance require careful consideration and arbitrary regulations as to structural details must frequently be observed whether the cost is justified or not.

Conductor cost should be balanced for permissible line loss at prevailing rates, and transformers, to prevent excessive core losses, should be so proportioned as to carry capacity loading as much as possible.

Fixed charges for distribution plant, based on right-of-way costs, leases or fees and equipment and structures costs may therefore also vary between very wide limits with perfect propriety.

Operating costs of the system depend on topography, multiplicity of lines, substations and terminals and their accessibility by rail or highway, weather conditions and special maintenance requirements for city lines, stream or railroad crossings.

Factors of Selling Price

Selling price depends on either the cost of a competitive product or rates fixed by a regulatory body; i.e., in the last analysis, by the purchaser.

The competitive product may be either purchased electrical power or produced power. Regarding the practicability of competition with purchased power, there can of course be no controversy. However, the feasibility of building a water-power plant or system for the competitive sale of electricity with that otherwise produced is not always so readily established. The selling cost of high-load-factor power, produced in large volumes with fuel at reasonable cost, is not, in general, appreciably higher than that produced by water, if in the latter case the transmission cost amounts to much.

In small fuel plants, however, and particularly when operating at a low load factor, it is at the present time impossible to produce power at a cost as low as that at which reasonably near and economically developed water power can be delivered.

But the efficiency of water-power-plant equipment and the overall efficiency of water-power production are already very high and only little improvement can ever be effected, while the efficiency with which fuel power is produced, both as to fuel transportation and conversion, is exceedingly low and great improvement may confidently be expected. Hence the present margin between selling costs of power produced by these several methods is not so great but that a pronounced improvement in the effective use of fuel may, in a great measure, jeopardize the investments made in water-power plants.

Effect of Regulation

To regulation we owe general recognition as public utilities and as such we are granted eminent domain for transmission-line rights of way, and sometimes for water rights. This means that we cannot be arbitrarily stopped from proceeding with certain plans

of development and that we do not have to pay very much more for property rights and easements than the market value thereof.

The impression prevails that, under regulation, the income of a utility is guaranteed. This is an utter fallacy. The income is merely limited, and in too many cases unfairly limited. Within the last few years earnings on securities have in too many instances had to be paid out of funds which should properly have been devoted to maintenance, or possibly unwise curtailments have had to be made in personnel. Deferred maintenance is the most serious disease with which a utility may be afflicted.

Theoretically, regulation is not so bad because, to that extent to which it is insisted that a high standard of service shall be maintained without discrimination as to rates, it benefits those who conscientiously administer this industry. This, however, is practice or service regulation and not rate regulation. Where competition is free, economic law operates to prevent continued exorbitant profit taking, the art is developed, and progress is made. Particularly with the power industry would this be the case.

Bearing on this question, the following issues are important:

Permitted rates of return on investment are inadequate

Certain otherwise irretrievable losses of income may not be covered by rates

Certain non-insurable risks may not be offset out of rates

Unfair competition is not throttled

Efficiency receives no reward.

A public utility that is not constantly expanding is decadent. New money must at frequent intervals be secured to finance extensions required from time to time, oftentimes under instructions of the commissioners.

In principle the returns on investment permitted under regulation are intended to be sufficient only for payment of interest and dividend, and for the perpetuation of the investment out of a depreciation reserve. The establishment of a sinking fund, out of earnings, is not proposed and borrowed money must therefore be kept in perpetuity.

It is of course both logical and proper that the depreciation reserve fund should be reinvested in the property to cover cost of extensions, but this money should in the first place, under healthy growth, be inadequate, and furthermore, once so invested the resources of the corporation become so non-liquid as to expose the administration to considerable financial embarrassment in cases of emergency when immediate funds should be available. At such times the desperate need for money is naturally and not without warrant taken advantage of because credit has been impaired.

Composition of Financial Structure

The financial structure which supports this industry is, in general, composed of:

A Lender: To whom payment of interest is compulsory under the security which he holds and which amounts to the entire property owned.

The lender sees to it that this is a safe risk. His criterion generally is that estimated net earnings shall be at least two times and generally two and one-half times the bond interest.

A Preferred Investor: In stock whose payment in dividends is substantially guaranteed under a lien subordinate only to the bondholders' equity. This investment is attended with all sorts of management and non-insurable structural risks.

A Speculative Investor: In common stock whose dividends are paid only if there is anything left over.

Customary and proper rates of return under respective security holdings may be set up as follows, based on the existing actual, not legal, interest rate for short-term collateral loans of equal volume:

	Per Cent				
Actual interest rate........	4	5	6	7	8
Bond interest.............	5	6	7	8	9
Preferred-stock dividend ...	7	8	9	10	11
Common-stock dividend....	10	$11^1/_2$	13	$14^1/_2$	16

One court held that the average rate of return on the entire investment should be three per cent above the existing interest rate.

The actual rate of return on capital ordinarily invested in any business enterprise is oftentimes lost sight of because it is confounded with the percentage of net profits made on units of output. If a turnover can be made four times in a year and a net profit of 6 per cent is made each time on the goods sold, the actual rate of return is 24 per cent and not 6 per cent. This is not at all an extraordinary performance.

A power plant is exceedingly fortunate if it makes a turnover once in four or five years. Returns permitted under regulation lie between 6 and 8 per cent. Some commissions may possibly, but not to our knowledge, allow more.

An ideal organization is one-third each of bonds, preferred and common stock and, with brokerage included as a capital cost, net earnings should be permitted as follows, as based on actual interest rates: 4 per cent and $7^1/_3$ per cent; 5 per cent and 8.5 per cent; 6 per cent and $9^2/_3$ per cent; 7 per cent and $10^5/_6$ per cent; 8 per cent and 12 per cent.

When commissions arbitrarily fix a rate of return which is not in keeping with financial conditions, money must be secured from such sources and at rates such that interest payments will remain within earnings. The result of non-observance of these fundamentals has been that utilities have been compelled to mortgage too large a part of their equities, bonded indebtedness has become dangerously great, and no new funds are available. Today permissible earnings are, in general, insufficient to attract new capital.

Unrecoverable Losses

Based on the law that utilities should not make unjust profits, it should equitably follow that they are entitled to protection against unjust losses. In financing such undertakings reliance is placed on constancy of return and rates are predicated on probable normal output. Industrial activity, however, varies in cycles and a falling off of normal business cuts into earnings in a manner which cannot be guarded against because, in general, equipment capacity kept in readiness to serve under contract provisions cannot be otherwise put to work. Contract minima, ordinarily, assure nothing more than the earning of bond interest alone.

Losses of output and therefore earnings are sometimes seriously affected by storm or flood conditions, against which the property cannot be guarded. Fire and breakdowns may, without fault on the part of the operating personnel, render normal service impossible and emergency service under any of these conditions is apt to be very expensive, but nevertheless practically obligatory. Interference with business by strikes, declaration of martial law, etc., mean unavoidable loss of income.

Against none of these contingencies can the management protect itself as this is customarily done and essential to safe business conduct, i.e., by the setting aside of a contingency or, as it has been called, a "stabilization," fund.

As to water power particularly, a development condition prevails which must be taken into account. The cost of prime movers is almost invariably only a small percentage of the total cost of all structures which must be completed in order to be able to manufacture any power whatever and the progressive development of the plant to meet the growing requirements of the market is more or less impracticable. Overdevelopment, therefore, is the rule, and since, for purposes of rate fixing, earnings are predicated on possible output instead of on probable demand, certain losses of income occur during the period required to bring sales up to the developed output capacity.

Under these unalterable circumstances the loss of earnings which are necessary to offset interest and dividend payments and the setting aside of funds to cover a depreciation which is actually going on, may legitimately be treated as development costs, either to be included in the capital cost on which the rate of return is based, or otherwise covered in the rate composition. One court, however, has held that any compensation for business losses in the adjustment of rates leads to a "reductio ad absurdum."

Quite enormous losses have been incurred by power companies due to great delay in the granting of those higher rates which the commissions by their own rulings have established as having been justified. Such requests of course grew very largely out of increased operating costs and to that extent to which they represent operating costs only and not the earnings of capital invested during the period of high prices, a future reduction in rates is to be expected. It remains to be seen whether it will be permitted that losses already sustained can be recouped before reductions in rates are ordered.

Floods may destroy dams and cause tremendous damage to persons and property. Lightning may burn up transformers and other equipment. Falling trees, wind or sleet storms may cut transmission lines in two and by short-circuit magnify the direct damage. Death-dealing currents take their toll of life regardless of even extraordinary precautions and, while such a risk is insurable, the amounts involved are limited and in any event defense in litigation is very costly.

Premature destruction of structures and equipment is not covered by the depreciation reserve and accidents requiring the outlay of additional capital without a corresponding increase in earning capacity can be covered only by a contingency reserve, provision for the accumulation of which should be included in the rate structure.

The antiquation or obsolescence of parts or even the whole of the plant through the possible development of novel equipment or methods for power production at lower selling cost than that possible with equipment now available or even by water power at all, is not too remote a happening to be given consideration, and this contingency should, in a measure at least, be offset by liberal present earnings.

That efficiently operating public utilities promote the welfare and growth of any community is obvious. If, therefore, the regulatory bodies would take a proper pride in the efficiency of the utilities which they regulate and would do everything to make it possible for the companies to deliver on sound financial bases the best service at the lowest rate, they would be doing their communities a signal service. Also in order to allay much of the antagonism toward public utilities fostered by political attacks, regulatory bodies should demand of all utilities under their jurisdiction, including the municipal plants, a uniform system of accounting such as to expose many of the fallacies now entertained.

Rates for electrical current are presumably based on cost of the service, painstakingly predetermined for each particular case. Cost of service is, however, susceptible to considerable modification depending on the degree of efficiency attained in administration of the property. If earnings are absolutely limited, the incentive to efficiency is lost and that is one of the most discouraging features of rate regulation. Zealous communism is only a theory.

Having in broad terms indicated some of the more vexing problems that confront the industry, an attempt will now be made to present as concisely as possible a schedule of economic considerations, the observance of which may lead to more satisfactory solution of these problems.

As to the Physical Structure

Design and Construction of Plant:

1 *Thorough Preliminary Study:* Geologically, meteorologically, legally and commercially. Such study requires time and money and both are too often curtailed.
2 *Control of Entire Stream:* To make regulation most effective and to prevent competitive injury.
3 *Degree of Stream-Flow Utilization:* The extent to which secondary power may be developed for sale or conversion into primary power.
4 *Best Use of Land or Water Rights:* Mechanical or automatic pond-level control to maintain a maximum head.
5 *Plan of Development or General Layout:* Location, utilization of site, (extent, method) progressive construction and stream regulation, location of auxiliaries, territorial control of market.
6 *Type of Structures or Detail Layout:* Kinds of dams, character of water channels, equipment setting, equipment housing, effective design for tail race, use of adjunct equipment, and belt-transmission trunk lines.
7 *Type of Equipment:* Prime movers suitable for characteristic load and service. Effective accessories. Adequate recording instruments, High-efficiency draft tubes and use of ejectors or tail-water elevation control. Air coolers for generators. High-potential generation or transmission. Automatic or semi-automatic generating stations and substations.

   Selection of Auxiliary Equipment. Ordinarily this should be high-capacity, quick-response, equipment of low first cost. Dependability is much more important than economy of operation, although low attendance costs are to be attained if possible. For this purpose there are best adapted steam turbines and boilers equipped with mechanically atomizing oil burners or powdered-coal-burning equipment. Heat balance is of secondary importance. Electrically operated auxiliaries are better for quick starting.
8 *Capacity of Equipment, Unit and Total:* Adaptability for characteristic load changes. Maintenance of balance, large and small units. Amplitude of reserve capacity. The cost of prime movers alone is generally only a small proportion of the total development cost and sufficient spare capacity should be installed.
9 *Economical Construction:* Effective building organization, executive, clerical, supervisory. Conscientious inspection. Economical purchasing. Reduction of unproductive construction period to the economical minimum. Assurance of service continuity by careful testing out.
10 Interconnection between power systems.

As to the Production Structure

Operation of Plant—Production and Distribution:

Routine:

1 Regular inspection and tests; owner's installation and customer's installation.
2 Effective service records and accounting.
3 Proper use, maintenance and loading of equipment.
4 Maintenance of balance between water and auxiliary power. Assuming storage to exist, it is generally best when an auxiliary plant requires operation, to operate it at full load, taking peaks on the water-power plant.
5 Fuel-efficiency control. Volume purchase by combined interests on specification basis under strict supervision.
6 Perfect load dispatching based on meteorological observations.

Administrative:

1 Proper selection of employees.
2 Education and training of employees—general, specific. Explicit written instructions should be furnished each employee setting forth his duties, methods of accomplishment and reasons for performance. Maintenance of discipline.
3 Development of loyalty and coöperation in employees. This may be brought about by fair dealing, manifest integrity of purpose, welfare work, encouragement by public recognition of especially meritorious service, appreciative adoption of suggestions and partnership in the business which should be made easy.
4 Acquirement of expert detail knowledge of the business in a manner to make information instantly available for effective analysis and synthesis.
5 Research and investigation to perfect methods which information should be coöperatively interchanged.

As to the Commercial Structure

Selling the Service:

1 Perfection of service.
2 Saturation of system; development of rural loads.
3 Selection of load. While the service requirements in a given market are quite characteristic, some improvement is generally possible. The diversity factor may be improved, the maximum demand may be cut down and the load factor may be raised by the encouragement of off-peak loading. Electrolytic processes, electrical industrial heating, domestic use of heat in all manner of appliances, and off-peak pumping and similar intermittent service suggest themselves as desirable loads.
4 Protective contract provisions: Service classifications, unavoidable interruptions of service not to be penalized, maximum demand limitations, power-factor penalties and bonus, fuel clauses, agreement to pass along extraordinary taxes, cost-of-living adjustment.
5 Classified service accounting to detect inadequacy of certain rates.
6 Development of a sympathetic, understanding attitude in consumer by intelligent publicity and helpful advice as to proper use of current and equipment.
7 Avoidance of too preponderant a load from either one or just a few consumers or either one or several closely allied industries.

As to the Financial Structure

Providing Funds:

1 Balance in equities of classified security holders.
2 Adequate working capital provisions.
3 Bond issue under a series mortgage.
4 Consumer partnership.
5 Reinvestment of depreciation reserve.

In all of the above it must be remembered that small plants require different treatment from that accorded to big plants and that isolated plants must be quite differently planned from those forming part of a chain or system.

In the light of what has gone before the question as to whether water-power development is a paying proposition may now more intelligently be answered.

Water-power development *does* pay—never big, however, but even very small plants of high unit cost entirely justify their existence. It *does not* pay at this time because the public will not invest in securities at interest or dividend rates which permit the financing of such undertakings on a basis of present permissible earnings.

However, these facts notwithstanding it is a gloriously constructive work and, because of the individuality of each project and the ever present hazard, it certainly may be ranked as the greatest sport on earth.

Heat Losses from Bare and Covered W. I. Pipe at Temperatures up to 800 Deg. Fahr.

By R. H. Heilman,[1] Pittsburgh, Pa.

High-temperature superheated steam running up to 800 deg. fahr. and high-temperature chemical processes are being more and more widely used, and accordingly the question of heat losses from pipes under such temperature conditions is one of importance to the engineering profession.

This paper presents the findings of an experimental investigation conducted in the Mellon Institute of Industrial Research of the University of Pittsburgh. The losses from bare wrought-iron pipes have been measured for temperatures up to and including 800 deg. fahr. They have been studied carefully for pipes of various diameters, and empirical formulas are presented whereby the loss from insulated pipes of any diameter may be readily calculated.

Manufacturers of pipe coverings often are required to guarantee that the application of a specified heat-insulating covering will effect a certain percentage saving of the heat which would be lost entirely from a bare pipe. Since the bare-pipe loss is the 100 per cent value against which the losses from the covered pipe must be compared, it is essential that the loss from the bare pipe shall be known accurately.

Many investigators have studied the heat losses from bare pipes. Perhaps the most noteworthy of those experimentalists was the French physicist Péclet. Owing, however, to the fact that Péclet's experiments were conducted at very low temperatures, while subsequent investigators confined themselves mostly to one pipe size only, the Mellon Institute deemed it advisable to carry on the research to much higher temperatures and on 1-in., 3-in., and 10-in. pipe.

The 1-in. pipe was selected for test at the higher temperatures, as the relatively small amount of heat loss from a 1-in. pipe could not greatly affect the room temperature. This pipe was run up to a temperature of 800 deg. fahr. The average room temperature throughout this test was 81 deg. fahr. and the temperature did not vary more than 1.8 deg. fahr. during its progress.

The locations of the curves for the 3-in. and the 10-in. pipes were obtained by experiment at the lower temperatures, as indicated by the solid lines in Fig. 1. The values for the higher temperatures are the result of extending the curves parallel to the curve obtained for the 1-in. pipe. This procedure was necessary because of the fact that the larger pipes could not be raised to the higher temperatures without raising considerably the temperature of the room.

In Table 1 the loss in dollars and cents and in pounds of coal per 100 lineal feet of horizontal bare iron is tabulated for temperatures up to 664 deg. fahr. The loss varies from $1.32 for 100 lineal feet of ½-in. pipe at 180 deg. fahr. to $297.50 for 100 lineal feet of 18-in. pipe at 654 deg. fahr.

TABLE 1 LOSSES FROM HORIZONTAL BARE-IRON STEAM PIPES

From 100 Lineal Feet of Pipe per Month of 30 Days with Steam in Pipes 24 Hr. per Day. Coal at $4.00 per Ton of 2000 Lb.

Gage Press.	Hot Water			10 Lbs.			80 Lbs.			120 Lbs.			160 Lbs.			200 Lbs.			200 Lbs. and 100° F. Superheat.			275 Lbs. and 250° F. Superheat.		
Temp.	180° F			239.4° F.			324.0° F.			350.0° F.			370.7° F			387.9° F.			487.9° F			664.3° F.		
Pipe Size	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.	Dollars Loss	Pounds Coal	B.t.u. per Lineal Ft. per °F. Diff. per Hr.
½"	1.32	526	.605	2.24	897	.670	3.92	1566	.779	4.51	1805	.815	5.25	2010	.846	5.53	2210	.875	8.60	3440	1.040	16.15	6460	1.375
1"	1.91	763	.878	3.26	1305	.973	5.72	2290	1.138	6.25	2601	1.178	7.27	2910	1.242	8.07	3230	1.280	12.56	5026	1.520	30.55	12220	2.600
1½"	2.65	1060	1.220	4.54	1818	1.357	7.98	3190	1.586	9.28	3710	1.676	10.42	4165	1.751	11.36	4550	1.804	17.94	7175	2.170	34.30	13720	2.920
2"	3.24	1297	1.491	5.36	2142	1.600	9.78	3910	1.943	11.37	4549	2.052	12.75	5100	2.145	14.00	5600	2.220	22.10	8825	2.670	42.20	16890	3.590
2½"	3.86	1545	1.778	6.65	2660	1.984	11.66	4660	2.320	13.66	5460	2.464	15.25	6100	2.564	16.70	6690	2.650	26.64	10650	3.220	50.50	20200	4.300
3"	4.56	1824	2.100	8.24	3292	2.460	13.88	5550	2.760	16.14	6450	2.910	18.04	7210	3.030	19.84	7945	3.150	31.60	12640	3.820	58.25	24300	5.170
3½"	5.18	2070	2.380	8.89	3554	2.655	15.82	6325	3.145	18.31	7322	3.305	20.50	8200	3.450	22.60	9040	3.580	35.90	14360	4.345	69.00	27600	5.860
4"	5.78	2305	2.650	9.87	3950	2.950	17.70	7075	3.520	25.50	8200	3.700	22.85	9145	3.842	25.15	10060	3.981	40.10	16040	4.850	72.40	30920	6.580
4½"	6.35	2540	2.920	10.94	4370	3.260	19.48	7790	3.876	22.60	9025	4.075	25.30	10120	4.250	27.75	11100	4.400	44.05	17620	5.326	85.60	34240	7.286
5"	6.95	2780	3.200	11.97	4790	3.575	21.25	8500	4.232	24.62	9850	4.450	27.60	11050	4.650	30.40	12140	4.805	49.35	19740	5.960	94.50	37800	8.050
6"	8.20	3280	3.775	14.21	5680	4.240	25.30	10110	5.024	29.30	11720	5.295	32.80	13120	5.522	36.00	14420	5.715	57.50	23000	6.955	112.50	45000	9.580
7"	9.40	3760	4.325	16.18	6470	4.826	29.10	11640	5.782	33.70	13480	6.090	37.60	15040	6.324	41.60	16650	6.560	66.25	26500	8.010	129.00	51550	10.97
8"	11.00	4398	5.050	18.25	7300	5.450	32.60	13030	6.455	37.65	15050	6.840	42.40	16940	7.125	46.05	18420	7.300	74.75	29900	9.050	146.20	58500	12.44
9"	11.62	4650	5.350	20.35	8130	6.070	36.25	14500	7.210	42.10	16840	7.600	47.22	18900	7.950	51.98	20790	8.230	83.50	33400	10.10	162.60	65050	13.84
10"	12.68	5065	5.925	22.05	8820	6.584	40.20	16100	8.010	46.70	18690	8.440	52.30	20910	8.805	57.75	23100	9.150	97.50	39000	11.18	180.00	72000	15.30
12"	15.00	6000	6.995	26.44	10580	7.890	47.40	18950	9.425	55.40	22120	10.00	61.76	24700	10.40	70.00	28010	11.14	109.30	43700	13.22	213.50	85500	18.18
14"	16.60	6635	7.625	28.90	11560	8.620	52.00	20800	10.34	60.50	24200	10.92	67.50	27000	11.36	74.10	29650	11.76	119.40	47740	14.43	233.00	93300	19.85
16"	18.82	7525	8.650	32.80	13120	9.790	58.76	23500	11.70	68.40	27320	12.34	76.10	30410	12.80	84.25	33700	13.35	135.00	54000	16.34	265.00	106000	22.55
18"	21.00	8400	9.650	36.10	14460	10.80	65.40	26150	13.00	76.50	30570	13.80	85.50	34200	14.38	93.75	37500	14.87	151.20	60500	18.30	297.50	119000	25.30

[1] In this table coal has been figured at $4.00 per ton of 2000 lb., 13,000 B.t.u. per lb. of coal; labor, boiler-room expense, etc., taken at $1.00 per ton, making total value of coal fired at $5.00 per ton. Boiler efficiency taken at 70 per cent; air temp. 70 deg. fahr. Experimental data obtained at the Mellon Institute.

Theory of Heat Loss from Insulated Pipes

In order to calculate the loss of heat from an insulated pipe or boiler, it is necessary to know the total temperature drop from the pipe to the surrounding air; and to enable one to make accurate calculations it is required that the component temperature drops be known.

The total temperature drop from the steam inside a pipe to the outer air can be considered as made up of four components, as follows:

a Drop from steam to the outer surface of the pipe

b Drop from outside surface of the pipe to inside surface of the insulation

c Drop from the inside surface of the insulation to the outside surface of the insulation

d Drop from outside surface of the insulation to the surrounding air.

[1] Industrial Fellow, Mellon Institute. Jun. Mem. Am.Soc.M.E.

Abridgment of paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

The temperature drop from the steam to the outer surface of the pipe depends upon the resistance to heat flow offered by the film at the inner surface and the resistance offered by the iron wall of the pipe. No attempt was made to measure this temperature drop in the present investigation, as it was considered to be so small as to be negligible.

The temperature drop from the outer surface of the pipe to the inner surface of the covering for 1-in., 3-in., and 10-in. pipe is shown in Fig. 2. These curves show that the temperature drop increases as the pipe diameter decreases. A test was also made on a 3-in. pipe with an air space of 1.2 in. between the surface of the pipe and the insulation. By comparing this curve with the curve for an air space of 0.1 in., it is observed that the temperature drop for a 1.2-in. air space is only a few degrees more than for an air space of 0.1 in. This is probably due to the fact that for air spaces much greater than 0.2 in. convection currents are increased, thus causing an increase in heat loss. An examination of Fig. 2 shows that the

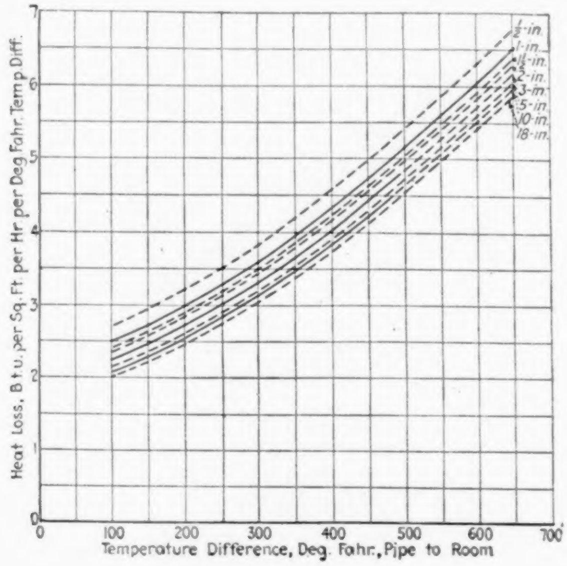

FIG. 1 BARE-PIPE LOSS CURVES

temperature drop for a 0.1-in air space is approximately equal to that for 0.1 in. of commercial insulations, so that this temperature drop can be neglected in calculations and the pipe covering considered as fitting close to the pipe with the pipe temperature and the temperature at the outer surface of the covering as the temperatures bounding the covering.

The drop in temperature, or the temperature-gradient curve through the insulation, depends upon the thickness of the covering and the curvature. In a cylindrical covering the resistance to heat flow diminishes as the outer surface is approached, the temperature drop becomes less, and the gradient curve is bowed downward if the curvature alone is taken into consideration. However, the absolute conductivity decreases as the outer surface is neared, with a consequent bowing up of the gradient curve, and the two tend to counteract each other, so that the temperature-gradient curve may be bowed either up or down or be a straight line, depending upon the curvature of the cylinder. The temperature-gradient curve for a flat surface should bow up.

It is highly desirable that tests should be conducted on commercial steam-pipe coverings of different thicknesses and at different temperatures, in order to obtain mean absolute-conductivity curves for the different thicknesses.

The temperature drop from the outer surface of the insulation to the surrounding air depends upon the amount of heat emitted by radiation and air contact. This in turn is dependent upon the nature of the surface of the body, the shape of the body, the excess of its temperature over that of objects to which radiation takes place, and the absolute value of the temperature of these bodies. Commercial steam-pipe coverings are invariably covered with a canvas jacket. From the above-mentioned facts it is obvious that the loss from a canvas surface at a given temperature is independent of what is under the canvas, so that, if the canvas-loss law can be ascertained, this law may be applied to the loss from steam-pipe coverings and thus the temperature of the outer surface of the insulation, can be determined. In making calculations of heat loss through an insulation, it is absolutely necessary to know the temperatures at the inner and outer surfaces.

Péclet made a careful study of the heat emissivity from various surfaces, canvas surfaces included. As mentioned, however, his experiments were conducted at relatively low temperatures. McMillan[1] made a study of the heat emissivity from a canvas surface in his study of commercial steam-pipe coverings, but confined his experiments to one pipe size only. Nevertheless, McMillan's results in the form of a curve present a readier means of calculating the losses from steam-pipe coverings than do Péclet's, whose observations, while taking all the variables into consideration, are in too complicated a form to provide a ready means of calculation.

Since McMillan's canvas-surface-loss curve was obtained from experiments on one pipe size only, this curve can be used in making calculations on coverings of a diameter approximately the diameter of the coverings tested. In order to be able to calculate the loss of heat from pipe coverings of any diameter, it has been necessary to obtain the canvas-surface-loss curves for various diameters. Accordingly, coverings were tested on the 1-in., 3-in., and 10-in. pipes used in determining the bare-pipe losses. The average outer diameters of the coverings used were 3.1 in., 9.5 in. and 17.2 in. The results of these tests are shown in Fig. 3.

In order to simplify the calculations necessary to determine the

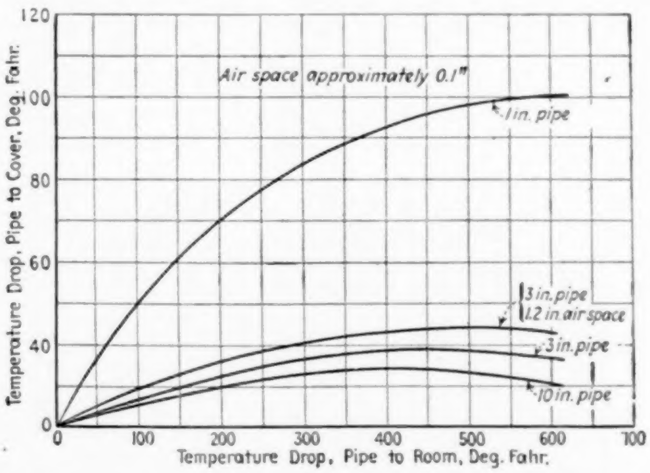

FIG. 2 TEMPERATURE DROP FROM OUTER SURFACE OF PIPE TO INNER SURFACE OF COVERING

loss of heat through coverings of various diameters, an equation for the three curves shown in Fig. 3 has been derived. In this equation

$$T_d = \frac{272.5\,h}{h + \dfrac{564}{D^{0.19}}} \qquad [1]$$

T_d = temperature difference between canvas surface and room, deg. fahr.

h = total B.t.u. loss per hour per square foot of canvas surface

D = outer surface diameter, inches.

This equation is approximately accurate for diameters up to 2 ft.

Thermocouples were used in determining the canvas temperatures. During this investigation it was found that the couple when just inserted under the canvas, would invariably read low. This difficulty was overcome by inserting it under the canvas for a distance of several inches, this distance depending upon the size of the couple and the temperature of the covering.

SAMPLE CALCULATIONS

A covering 2 in. thick, having a mean absolute-conductivity coefficient of 0.56, is placed on a $4^1/_2$-in. outside-diameter pipe maintained at a temperature of 400 deg. fahr. The temperature of the surrounding air is 700 deg. fahr. Determine the heat flow H in B.t.u. per hour per sq. ft. of pipe surface.

[1] Trans. Am.Soc.M.E., vol. 37, p. 928.

The heat flow through a cylinder is given by the following equation:

$$h = \frac{K(T_1 - T_2)}{r_1 \log_e \frac{r_2}{r_1}} \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where T_2 is the temperature at the outer surface of the covering. To obtain T_2, knowing only T_1, the pipe temperature and T_3, the room temperature, it is necessary to change the form of the equation so as to include T_4, thus:

$$h = \frac{K(T_1 - T_3 - T_4)}{r_2 \log_e \frac{r_2}{r_1}} \ldots\ldots\ldots\ldots\ldots [3]$$

in which

K = mean absolute conductivity of insulation
r_1 = radius of inner surface of insulation, inches
r_2 = radius of outer surface of insulation, in inches
T_4 = value given by Equation [1].

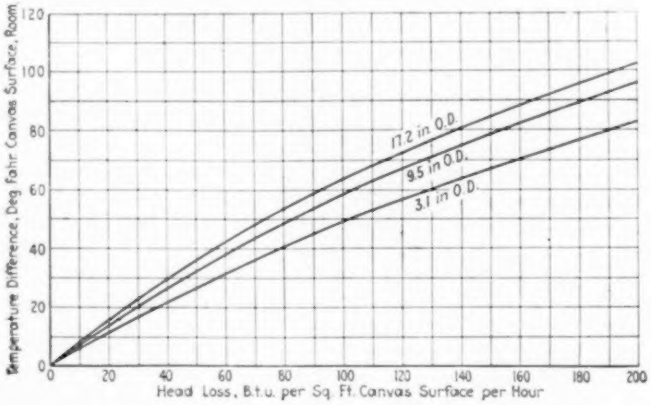

Fig. 3 Canvas-Surface Loss-Curves

Substituting in [3], there results

$$h = 0.56 \left[\frac{400 - 70 - \dfrac{272.5\,h}{h + \dfrac{564}{8.5^{01.9}}}}{4.25 \log_e \dfrac{4.25}{2.25}} \right]$$

$$= 0.207 \left(330 - \frac{272.5\,h}{h + 375}\right)$$

$$= \frac{-\sqrt{363.1 \pm 363.1^2 + 4 \times 25{,}600}}{2} = 60.4$$

whence $H = 60.4 \times \frac{4.25}{2.25} = 114$ B.t.u. loss per sq. ft. of pipe surface.

The temperature of the outer surface of the covering can be obtained by substituting the value of h in the equation $T_4 = 272.5\,h/(h + 375)$, reducing to $T_4 = 37.6$. Therefore the temperature of the outer surface of the covering is

$$37.6 + 70 = 107.6 \text{ deg. fahr.}$$

Discussion

In discussing Mr. Heilman's paper, L. L. Barrett[1] wrote that the author's statement that a 0.1-in. air space between the pipe and insulation increased the overall loss was not apparently borne out by the further statement that the temperature drop for a 0.1-in. air space was approximately equal to that of 0.1 in. of insulation. It was unfortunate, he wrote, that the impression was given that conductivity was related to the curvature of the covering. Conductivity was a specific property of the material, independent of shape. He wrote at length on the theory of heat loss from pipes, and the relation between conductivity and temperature

[1] Mgr. of the Engrg. Dept., Keasbey & Mattison Co., N. Y. City. Assoc-Mem. A.S.M.E.

L. B. McMillan[1] wrote that it was interesting to note that the author's results on losses from various sizes of bare pipes showed smaller differences between large and small pipes than those given by Paulding. He was of the opinion that the author's curves were more nearly correct than Paulding's. He pointed out that temperature drop depended not only on resistance of the air space but also on the amount of heat flowing across the air space and out from the insulation. He also called attention to the apparently contradictory statement regarding the 0.1-in. air space, and to the fact that the absolute conductivity was a specific property of the material and was independent of its shape or size.

B. N. Broido[2] called attention to the property of superheated steam of not readily giving up its heat, and said that, although this was less evident in covered than in bare pipe, it still was an important property to take advantage of in power plants because no covering could be a perfect insulator. In the table of losses from bare-iron steam pipes, he said, the author made the same error as many of the pipe-covering manufacturers in giving the pounds of pressure of the steam and the superheat in degrees fahrenheit, corresponding to the total temperature, which gives the impression that the tests are made with superheated steam actually flowing through the pipe, while as a matter of fact these tests are made with electrically heated pipe. The radiation losses, as well as the temperature of the wall, if superheated steam of the given temperature and superheat were flowing through the pipe, would be considerably less.

Discussion on Accuracy of Boiler Tests

(Continued from page 430)

Nevin E. Funk[3] asked whether the author's statements regarding the sampling of steam were a theory or had been subjected to rigorous test. He pointed out that saturated steam was not, as a rule, generated in modern boilers as they are generally equipped with superheaters. He could see no reason for stating the performance of a boiler in B.t.u. per 100 B.t.u. in the coal, as suggested by the author, as it would be the same as stating the efficiency.

Edwards R. Fish,[4] who presented the paper in the absence of the author, said, in closing the discussion, that differences of opinion had been expected, and that the opinions expressed only illustrated the fact that the whole art was more or less uncertain. He spoke of the new boiler test code and its emphasis upon accuracy. The boiler tests shown by the author were of commercial rather than research type and were subject to greater variations than the latter type, but were made by highly trained experts with the best of apparatus and refinements. The author's remarks about sampling steam were based on theory; no attempt had been made to check them.

In a discussion submitted after the meeting R. F. Burke[5] criticized the steam-sampling nozzle recommended by the A.S.M.E. Boiler Test Code and suggested a calorimeter nozzle having three openings, one in the center and one near each side, proportioned so that the velocity of the steam will be the same through the calorimeter nozzle and calorimeter. Mr. Burke spoke of the difficulties of getting accurate coal-consumption figures in short tests. He stated as his belief that the correct way to judge the amount of coal on the grates of an underfeed stoker is by the draft differential, which should be the same at the beginning and end of a test. He called attention to the possibility of error in measuring water unless constant level starting fifteen minutes before the test is maintained throughout the test. He further expressed the opinion that the efficiency of boilers should be determined upon temperature and flue-gas analysis rather than on the amount of coal burned and water evaporated.

[1] Cons. Engr., Johns-Manville, Inc., New York, N. Y. Assoc-Mem. Am.Soc.M.E.
[2] Development Engr., Locomotive Superheater Co., New York, N. Y. Mem. Am.Soc.M.E.
[3] Operating Engr., Phila. Elec. Co., Phila., Pa. Mem. Am.Soc.M.E.
[4] Vice-Pres., Heine Boiler Co., St. Louis, Mo. Mem. Am.Soc.M.E.
[5] Heine Boiler Co., Phoenixville, Pa.

The Control of Boiler Operation

Simplified Formulas for Use in Calculating Chimney, Combustion and Absorption Losses —A Proposed Fuel Unit for Bituminous Coal, etc.

By E. A. UEHLING,[1] MILWAUKEE, WIS.

The problem the author sets for himself is to suggest a method that will bring complete and intelligent control of boiler operation, so far as combustion and absorption efficiency are concerned, within the horizon of comprehension and easy execution of the average operating engineer, enabling him to determine heat losses and to separate them into their several components so that he can know just where and to what extent losses occur, and that he may be better able to minimize them by intelligent application of the proper remedy. The author proposes the pound-carbon fuel unit, which he shows to be practically equicalorific, and which in B.t.u. equals 14,450 plus 62,000 times the percentage of available hydrogen.

Formulas are presented for calculating heat losses up the chimney and the combustion and absorption losses are analyzed. The application of the formulas to some scientifically conducted tests is shown.

OUR Government, through its research departments of the Bureau of Mines and the Geologic Survey has made and published thousands of analyses, ultimate as well as proximate, covering all the coals of the United States, Alaska, etc. These analyses are all available and they are both interesting and instructive; but long tables of analyses are of no practical use to the operating engineer. He must have specific information of the ratio of heat input to the heat utilized or the heat wasted, it matters not which, in order to know how efficiently or wastefully his boilers are operating.

The Equicalorific Fuel Unit

The pound of coal as received is and will probably remain the commercial fuel unit, but because of great variation in heating value it is a most unsatisfactory control unit. This has long been recognized by combustion experts, and the pound of combustible has been adopted as the fuel unit for comparing boiler efficiencies. This unit, although it eliminates the variation in heating value due to the ash and moisture in coal, is practically equicalorific only between narrow limits of oxygen.

The heating value of the pound-carbon fuel unit is $14{,}550 + 62{,}000H_a$ B.t.u., where H_a is the available hydrogen per pound of carbon, and for practical control purposes this unit is essentially equicalorific, as is shown in the complete paper.

Methods for Ascertaining Economic Operation

There are two distinct methods for ascertaining the economic operation of a boiler:

a By determining the percentage of the heat in the fuel utilized

b By ascertaining the percentage of heat wasted.

The first is the simpler and therefore most generally practiced way. It answers well as an overall control, but does not raise the endeavor to improve boiler operation beyond the old cut-and-try methods, hence cannot lead to continuous maximum boiler efficiency. The second method, as practiced when attempted at all, is apparently more intricate and difficult than the first, and is but little understood by even the most up-to-date operating engineer. The heat losses are determined by the combustion experts for the purpose of establishing a heat balance, but heat balances mean little or nothing to the average operating engineer, and even when understood and appreciated they are of little or no help to him in controlling boiler operation. The engineer is continually confronted by contradictory advice: On the one hand, he is told that CO_2 is the all-important control factor. Keep CO_2 a maximum and heat losses will be a minimum. Carbon dioxide is the index of efficiency. On the other hand, he is admonished that CO_2 is an unreliable index; high CO_2, because of accompanying CO, is likely to cause greater heat loss than low CO_2. A third person tells him not to bother about CO_2 and CO but to keep air flow and steam flow in unison and maximum efficiency will result. Confronted by such conflicting statements, operating engineers and many power-plant managers become confused rather than enlightened.

Boiler efficiency rests on combustion efficiency and absorption efficiency and these are as distinct one from the other as boiler efficiency is from engine efficiency. The first is a chemical phenomenon which can be adequately diagnosed only by chemical means, and the second a physical phenomenon which must be diagnosed by physical means; without adequate diagnosis the remedy must be guessed at, and if it happens to be guessed correctly it is rarely intelligently and effectively applied. This is a scientific truism which must be borne in mind if we are to attain and maintain maximum economy in the operation of steam boilers. All other methods of control, helpful though they may be, cannot lead to maximum efficiency.

The heat carried to waste up the chimney can be ascertained only by analyzing the gas and measuring its temperature on leaving the boiler. To exercise intelligent control the heat in the gas must be divided into available and unavailable heat. The latter depends on the theoretical maximum percentage of CO_2 obtainable from the fuel used and the temperature of the water in the boiler.

This temperature, below which it is impossible to cool the gas by absorption, depends on the steam pressure which is practically constant for any given boiler, and since the maximum percentage of CO_2 is also constant, it follows that unavailable heat in the gas must be constant. The difference between the total heat and the unavailable heat is the available heat loss. The available heat loss is again composed of two parts, viz., that due to excess air and that caused by excess temperature. This analysis of the heat loss provides the means for intelligent control of boiler operation.

To enable the operating engineer to ascertain and analyze his heat losses he must know the percentage of CO_2, the temperature of the gas as it leaves the boiler and the boiler draft. These three controlling factors must be continuously autographically recorded. The percentage of CO must be kept within tolerable limits, as will be shown further on in the paper.

The temperature of the gas depends on:

a The rate of combustion

b The cleanliness of the heating surface

c The condition of the baffling

d The tightness of the setting.

The boiler draft is affected by all of these conditions and is therefore essential to interpret properly the cause of temperature variation. The product of the square root of the boiler draft and the CO_2 is a reliable index to the rate of combustion when the boiler and setting are in good condition.

Having autographic records of the essential control factors is one thing; to make effective use of the information they contain is quite another. Records of whatever kind are useless unless they are regularly scrutinized and correctly interpreted and compared and the information deduced promptly applied. To apply this information intelligently it must be put into concrete form, i.e., into B.t.u. and percentage of the heat supplied; and here is where the average operating engineer is practically helpless and it is the real cause of the adverse attitude already referred to, his aversion to scientific methods of control. To overcome this attitude heat-loss calculations must not only be brought within the horizon of his ready comprehension, but they must be made so easy that he can make them with the least trouble and expenditure of time.

[1] Consulting Engineer. Mem. Am.Soc.M.E.

Abridgment of paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

The Author's Heat-Loss Formulas

In an appendix to his paper on the Physical and Chemical Control of Boiler Operation,[1] the author deduced a set of formulas for calculating the heat losses up the chimney, which are again presented below in slightly modified form. These formulas attracted no attention at the time nor have they since, at least no comment upon them has come to his notice. The reason for this may have been that they are all based on the pound-carbon fuel unit, the advantages of which were not then apparent.

The formulas are as follows:

$L_d = (0.24 + 58.46/CO_2) \times (T - t)$
= B.t.u. carried to waste by the dry gas..................[1]

$L_c = 10{,}150\ CO/(CO + CO_2)$
= B.t.u. loss due to CO contained in gas..................[2]

$L_h = H_t \times [(10{,}642 - 9t) + 4.3\ (T - 212)]$
= B.t.u. carried to waste by the steam contained in the gas; H_t = weight of total hydrogen per pound of carbon in the coal, including the moisture..........................[3]

$$A_e = \frac{2100}{(1 + 3H_a) \times CO_2} - \frac{100 + 238H_a}{1 + 3H_a}$$
= per cent excess air..................................[4]

$O_c = 21 - CO_2 \times (1 + 2.38H_a)$
= per cent excess oxygen...............................[5]

$MCO_2 = 21/(1 + 2.38H_a)$
= maximum per cent of CO_2 obtainable from the fuel burned..[6]

$A_w = 243.6/CO_2 + 8Ha$
= pounds of air supplied per unit of fuel consumed........[7]

$G_w = 1 + 243.6/CO_2$
= pounds of dry gas produced..........................[8]

$A_v = 3192/CO_2$
= cu. ft. of dry gas at 62 deg. fahr......................[9]

$S_w = 9H_t$
= pounds of steam in gas..............................[10]

Z = square root of the boiler draft.....................[11]

$Z \times CO_2$ = index of rate of combustion....................[12]

The Control Factors

To establish a heat balance the B.t.u. supplied by the air must be deducted from the heat in the gas, hence the temperature factor $(T - t)$ must be used in Formulas [1] and [3], but as already stated, heat balances are of no use for direct, prompt, and continuous control. To enable the operating engineer to exercise effective control over combustion and absorption efficiency, he must know not only how much heat is carried to waste by the gases, but how much of this heat is available to the boiler and what part of the available heat loss is chargeable to the process of combustion and how much to absorption; and since all the heat brought in by the air is contained in the unavailable part of the heat in the gas, the temperature of the air may be ignored, thus simplifying the formulas by eliminating a variable term. The calculations for determining the two essential control factors are:

$A = (0.24 + 58.46/CO_2) \times T$ = total B.t.u. in the dry gas, and

$B = (0.24 + 58.46/MCO_2) \times T_w$ = unavailable B.t.u. in the dry gas; then

$A - B$ = the theoretically available heat carried to waste by the dry gas. In Formula [3] the term $H_t(10{,}642 - 9t)$ represents latent heat which is all unavailable, hence if we let

$C = (4.3H_t) \times (T - 212)$ = total sensible heat in H_2O in the gas, and

$D = (4.3H_t) \times (T - T_w)$ = unavailable sensible heat in H_2O in the gas, then

$C - D$ = available heat in H_2O contained in the gas, hence

$(A + C) - (B + D) = E$ = total available heat carried to waste up the chimney.

The heat loss E is partly due to combustion and partly to absorption inefficiency.

Combustion and Absorption Losses

Combustion would be 100 per cent efficient if all the combustible elements in the fuel were completely oxidized in the furnace, using the theoretical weight of air required, and absorption would be 100 per cent efficient if it reduced the temperature of the gas resulting from 100 per cent efficient combustion to the temperature of the water in the boiler. The component parts of combustion losses are:

a The heat loss due to excess air
b The heat value of the unburned combustible in the gas $(CO + C_x + H_y)$, and
c The carbon in the ash.

The component parts of the absorption losses are:

a Heat loss due to dirty heating surface
b Heat loss due to defective baffling, and
c Heat loss due to excessive driving.

All these component parts of the waste of available heat can be determined from the interrelation between the three essential autographic records, for any particular time or any desired period, such as a test, a day or a shift, as follows:

Applying our formula we have:

$a = [(0.24 + 58.46/CO_2) - (0.24 + 58.46/MCO_2)]T$
= B.t.u. loss due to excess air.

The combustible constituents in the gas are CO and an undetermined weight of $(C_x + H_y)$. The heat value of the latter probably never exceeds 0.2 of the former in boiler flue gas, and is negligible when CO is kept within proper limits.

$b = 10{,}150\ CO/(CO + CO_2)$ = B.t.u. loss from CO in the gas.

c The B.t.u. loss due to unburned carbon must be determined by analyzing the ash. We have then

$C_{ef} = 100 - (a + b + c)/179$ = combustion efficiency.

The component parts of heat lost to absorption can be located on the autographic charts, but can be quantitatively determined by our formula only in total; thus:

$$A_{ef} = 100 - \frac{(0.24 + 58.46/MCO_2) \times (T - T_w)}{179}$$
= absorption efficiency.

The component parts of absorption loss may, however, be approximately determined, as will be shown by example further on.

Simplification of Formulas

All this may look like a rather formidable array of equations to place before the average operating engineer, with the expectation that he apply them successfully. Such expectation would be futile. The author, however, is not now confronting average operating engineers; he imagines he is addressing scientific as well as practical fuel conservationists and combustion experts, who will understand that the foregoing formulas are applicable to all commercial fuels from coke to natural gas, whereas operating engineers rarely have to deal with more than one kind of fuel at a time. Limiting ourselves for the present to bituminous coal, these formulas, being based on the equicalorific fuel unit, can be greatly simplified and those essential for control reduced to few in number.

In Formula [1] the factor $(0.24 + 58.46/CO_2)$ is equal to the B.t.u. per degree of temperature contained in the weight of dry gas produced in burning one unit of fuel. Letting X equal this value, then XT = total B.t.u. in dry gas per unit of fuel. Substituting the average value of H_a (= 0.054) in Formula [6], we have $MCO_2 = 21/1.128 = 18.6$ per cent = the theoretical maximum percentage of CO_2 obtainable from bituminous coal. Using this value of CO_2 in Formula [1] we have $(0.24 + 58.46/18.6) \times T_w = 3.38T_w$ = B.t.u. of unavailable heat in dry gas. T_w varies with steam pressure, but since this is practically constant for any given boiler plant, $3.88T_w$ is also constant. $XT - 3.38T_w$ = B.t.u. of available heat. Now since X represents the total B.t.u. per degree of temperature in the weight of dry gas resulting from the combustion of one unit of fuel burned with an excess of air, and 3.38 = B.t.u. of heat per degree of temperature in the weight of gas that results when a unit of fuel is burned with the theoretical weight of air required for complete combustion, we have $(X - 3.38)T$ = B.t.u. of available heat wasted because of excess air and $3.38\ (T - T_w)$ = B.t.u. of available heat wasted due to excess temperature.

[1] Trans. Am.Soc.M.E., vol. 40, p. 714.

In Formula [2], 10,150 $CO/(CO + CO_2)$, the factor $CO/(CO + CO_2)$ represents the weight of carbon burned to CO. This formula can be somewhat simplified by letting $10{,}150 \times CO = Y$ so that $Y/(CO + CO_2)$ = B.t.u. wasted due to CO.

Our essential control formulas are then:

XT = total B.t.u. contained in dry gas................ [A]
$3.38\ T_w$ = B.t.u. unavailable in dry gas.............. [B]
$XT - 3.38T_w$ = B.t.u. available in dry gas.......... [C]
$(X - 3.38)\ T$ = B.t.u. loss due to excess air.......... [D]
$3.38\,(T - T_w)$ = B.t.u. loss due to excess temperature.. [E]
$Y/(CO + CO_2)$ = B.t.u. loss due to CO in gas........ [F]
$Z \times CO_2$ = index to rate of combustion.............. [G]

The value of $3.38T_w$ is practically constant for any given power plant. The values of X, Y and Z may be read off directly from

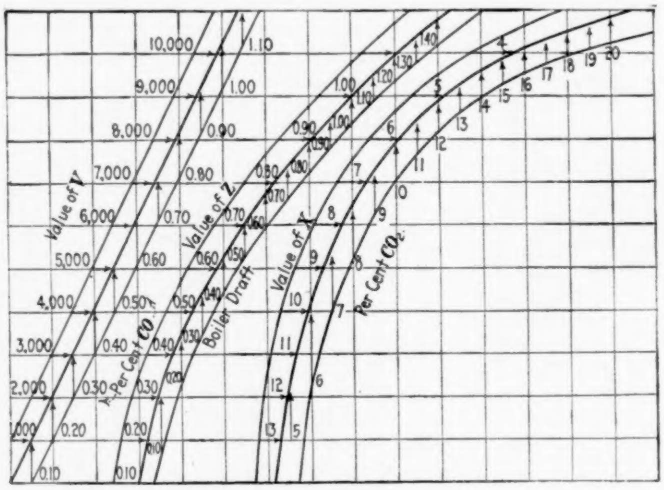

Fig. 1 Values of X, Y and Z

tables prepared for the purpose or they may be found from curves as shown in Fig. 1. Only a fraction of the B.t.u. in the steam contained in the gas is sensible heat and the greater part of this is unavailable to the boiler. The heat loss represented by Formula [3] therefore has no control value and may be ignored. By substituting the value of $H_a = 0.054$ in Formulas [4], [5] and [6], they reduce respectively to—

A_c = $1810.35/CO_2 - 97$ = per cent excess air....... [4a]
O_c = $21 - 1.13CO_2$ = per cent excess oxygen........ [5a]
MCO_2 = 18.6 = maximum per cent CO_2............. [6a]

The information derived from [4a] and [5a], though not essential for control purposes, may be desirable to have.

Combustion and absorption efficiency are the two factors on which economical boiler operation depends. Maximum absorption efficiency in any given boiler is maintained by keeping the boilers clean inside and out, and maintaining the baffling and setting in perfect condition. The former is a matter of routine conscientiously performed and the latter can be secured by proper and frequent inspection. If the proper tools are supplied, maintaining absorption efficiency is a simple matter. Combustion efficiency, on the other hand, is an entirely different proposition and cannot be maintained by any definite predetermined routine of operation. It depends on numerous and frequent adjustments: The rate of combustion must be adjusted to the steam demand. The draft must be adjusted to maintain the rate of combustion, the coal supply must be kept in harmony with the draft, and the firebed must be kept in condition to make the draft economically effective. The air supply must be adjusted so that the proper proportions enter, respectively, below and above the firebed. None of these adjustments can remain fixed but must be frequently changed as a whole and in relation to one another if maximum combustion efficiency is to be achieved.

It is not possible to maintain maximum combustion efficiency by inspection. Without the aid of the proper and necessary means for getting the essential data, boiler operation is necessarily a more or less haphazard performance, depending on intuition and guessing. To achieve the best results in any undertaking proper instruments must be provided. This is as true of operating boilers as it is of navigating a ship or conducting a scientific research. Suppose that in addition to the steam gage and water glass, which are always supplied (because required by law), the necessary instruments, viz., an Orsat, a continuous recording CO_2 meter and indicator, a recording pyrometer and a boiler draft gage have been properly installed. The first and most important step necessary to insure success is to put some one in charge and hold him strictly responsible for the continuous and correct functioning of the instruments. The principal cause for failure of such instruments is due to overlooking or neglecting this necessity. A further reason why so many installations of these instruments have not led to the results predicted or anticipated is that the operating engineer has had no simple means for getting the information autographically recorded into the form necessary for direct and intelligent application.

The object of the simplified control formulas is to bring the mathematics necessary to determine and locate the losses within easy reach of the average operating engineer, and especially to enable him to make the necessary calculations with the least expenditure of time and trouble. The fact that these formulas are based on the equicalorific fuel unit gives them a much greater practical value than their simplicity would indicate. It makes effective control of boiler operation quite independent of the analysis and heating value of the coal as fired. If the necessary equip-

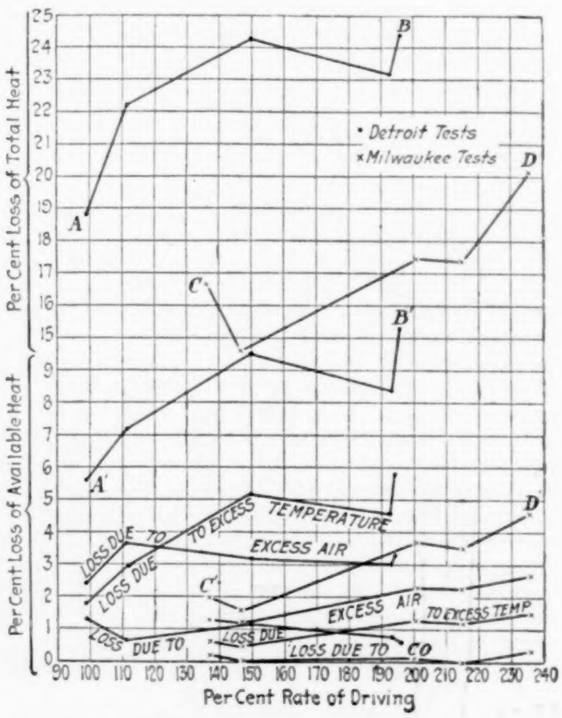

Fig. 2 Graphical Representation of Application of Heat-Loss Control Formulas

ment is provided, any up-to-date operating engineer should by the aid of such equipment and the simplified formulas be able to maintain the highest combustion and absorption efficiency that the structural and operating conditions of his plant (including the quality of the fuel used) will permit, and if maximum combustion and absorption efficiencies are maintained, minimum waste of fuel will necessarily result.

Application of Formulas

Tables 1 and 2 show the application of the heat-loss control formulas to ten scientifically conducted tests. These tables are self-explanatory. The tests treated in Table 2 were taken from the series of tests made of the large boilers of the Delray Plant of the Detroit Edison Company by Dr. Jacobus[1] as reported to

[1] Trans. Am.Soc.M.E., vol. 33, p. 565.

this Society in the paper which he presented at the Annual Meeting in December, 1911. Table 1 treats of the pulverized-coal tests made by Henry Kreisinger of the boilers of the Lakeside Power Plant of the Milwaukee Electric Railway and Light Co. as reported at the Spring Meeting, 1921. All the five tests reported are represented.

The results of applying the heat-loss control factors are graphically shown in Fig. 2. The graph AB represents the percentage of total heat wasted, i.e., 100 minus the per cent efficiency as found by tests of the Detroit Edison Company's boilers; and CD represents the total heat wasted as found by test of the Milwaukee Electric Railway and Light Co.'s boilers. $A'B'$ and $C'D'$ show the respective losses of available heat of these two sets of tests as determined by the control formulas. The other graphs show where and to what extent the loss of available heat took place. Comparing graphs AB and CD, respectively, with $A'B'$ and $C'D'$, it will be seen that they are quite similar in contour, and this close similarity demonstrates the reliability of the loss of available heat as an index of boiler efficiency. The reliability of this index can be disturbed only by excessive moisture in the coal or excessive loss of carbon through the grate. The former adds to the unavailable heat and hence cannot be controlled by the operating engineer, and much less by the fireman; the latter can be detected and roughly estimated by observation

TABLE 1 UEHLING HEAT-LOSS CONTROL FORMULAS APPLIED TO THE PULVERIZED-COAL BOILER TESTS OF THE LAKESIDE POWER PLANT, MILWAUKEE

	Data Essential for Control				
Number of test	1	4	3	2	5
CO_2 = Per cent carbon dioxide in gas	15.8	16.0	14.7	14.6	14.1
CO = Per cent carbon monoxide in gas	0.05	0.00	0.03	0.00	0.09
T = Temperature of gas on leaving boiler, deg. fahr.	434	430	482	475	490
T_w = Temperature of water in boiler, deg. fahr.	409	409	411	411	411
B_d = Boiler draft, i.e., resistance to gas through boiler, in water	0.30	0.355	1.03	0.92	1.2
RESULTS OF TESTS					
Pounds of coal consumed per hour	5980	6650	9560	9740	11350
Units of fuel consumed per hour	4114	4319	6331	6545	7424
Per cent rate of driving	137	147	209	215	236
Per cent boiler efficiency	83.3	85.4	82.5	82.6	79.8
CONTROL FACTORS OBTAINED FROM FIG. 5					
X = B.t.u. in dry gas per unit of fuel and degree of temperature	3.94	3.9	4.17	4.24	4.38
Y = 10,150 CO	508	0.0	344	0.0	914
Z = Square root of boiler draft (B_d)	0.55	0.59	1.01	0.957	1.09
ANALYSIS OF HEAT LOSSES					
XT = B.t.u. of total loss of sensible heat in dry gas	1710	1673	2034	2014	2177
XT_w = B.t.u. of unavailable sensible heat in dry gas	1382	1382	1389	1389	1389
$XT - 3.38T_w$ = B.t.u. of available sensible heat in dry gas	328	291	645	625	788
$(X - 3.38)T$ = B.t.u. loss of available heat due to excess air (a)	230 = 1.3%	219 = 1.2%	405 = 2.3%	408 = 2.3%	490 = 2.7%
$3.38(T - T_w)$ = B.t.u. loss of available heat due to excess temperature (b)	96 = 0.53%	68 = 0.41%	240 = 1.3%	217 = 1.2%	277 = 1.55%
$Y/CO + CO_2$ = B.t.u. loss due to CO in gas (c)	32 = 0.18%	00 = 0.0%	20 = 0.11%	0.0 = 0.0%	64 = 0.36%
$a + b + c$ = B.t.u. total loss of available heat in dry gas	358 = 2.0%	287 = 1.6%	665 = 3.7%	625 = 3.5%	831 = 4.6%
$100 - (a + c)\%$ = Combustion efficiency, per cent	98.5	98.8	97.6	97.7	96.9
$100 - b\%$ = Absorption efficiency, per cent	99.47	99.6	98.7	98.8	98.45
$100 - (a + b + c)\%$ = Combined absorption and combustion efficiency, per cent	98.0	98.4	96.3	96.5	95.4
ZCO_2 = Index of rate of combustion	9.16	9.53	14.7	14.6	15.44

TABLE 2 UEHLING HEAT-LOSS CONTROL FORMULAS APPLIED TO TESTS OF LARGE BOILERS OF THE DETROIT EDISON COMPANY

	Data Essential for Control				
Number of tests to which formulas were applied	5	3	6	17	18
CO_2 = Per cent carbon dioxide in gas	14.4	13.5	14.66	14.69	14.16
CO = Per cent carbon monoxide in gas	0.35	0.18	0.31	0.20	0.16
T = Temperature of gas on leaving boiler, deg. fahr.	483	542	662	636	694
T_w = Temperature of water in boiler, deg. fahr.	387	387	388	390	390
B_d = Boiler draft, i.e., resistance to gas through boiler, in water	0.08	0.18	0.31	0.61	0.78
RESULTS OF TESTS					
Pounds of dry coal consumed per hour	6606	8130	11295	13761	14987
Units of fuel consumed per hour	5083	6402	8963	11163	12480
Per cent rate of driving	94.0	113.8	150.7	193.3	195.7
Per cent boiler efficiency	81.15	77.45	75.28	76.73	75.57
CONTROL FACTORS OBTAINED FROM FIG. 5					
X = B.t.u. in dry gas per unit of fuel and degree of temperature	4.3	4.6	4.23	4.22	4.37
Y = 10,150 CO	3510	1850	3225	2000	1600
Z = Square root of boiler draft (B_d)	0.28	0.42	0.555	0.78	0.88
ANALYSIS OF HEAT LOSSES					
XT = B.t.u. of total loss of sensible heat in dry gas	2077	2493	2800	2684	3033
$3.38T_w$ = B.t.u. unavailable sensible heat in dry gas	1308	1308	1311	1318	1318
$XT - 3.38T_w$ = B.t.u. loss of available sensible heat	769	1185	1483	1366	1725
$(X - 3.38)T$ = B.t.u. loss due to excess air (a)	444 = 2.4%	661 = 3.7%	563 = 3.2%	534 = 3.0%	687 = 3.8%
$3.38(T - T_w)$ = B.t.u. loss due to excess temperature (b)	325 = 1.8%	524 = 2.9%	926 = 5.2%	832 = 4.6%	1038 = 5.8%
$Y/CO + CO_2$ = B.t.u. loss due to CO in gas (c)	232 = 1.3%	111 = 0.62%	215 = 1.2%	134 = 0.75%	119 = 0.66%
$a + b + c$ = B.t.u. total loss of available heat in dry gas	1001 = 5.6%	1296 = 7.2%	1704 = 9.5%	1500 = 8.4%	1844 = 10.3%
$100 - (a + c)\%$ = Combustion efficiency, per cent	96.3	95.7	95.6	96.25	95.7
$100 - b\%$ = Absorption efficiency, per cent	98.2	97.1	94.8	95.4	94.2
$100 - (a + b + c)\%$ = Combined combustion and absorption efficiency, per cent	94.4	92.8	90.5	91.6	89.7
ZCO_2 = Index of the rate of combustion	3.74	5.67	8.14	11.46	12.46

and promptly remedied. Fig. 3 shows the rate of combustion in its relation to the combustion index ZCO_2. As the graph shows, this necessarily varies with the type and size of boiler, the arrangement of baffling, etc. The characteristic of the graph must be determined for each type and construction of boiler. This done, it becomes a practically reliable check on the effort of the fireman to burn his proper share of coal in keeping up the steam pressure. Since the percentage of CO_2 is the principal factor in determining combustion efficiency as well as this index, the inefficient fireman is compelled to work harder to make his proper share of the steam.

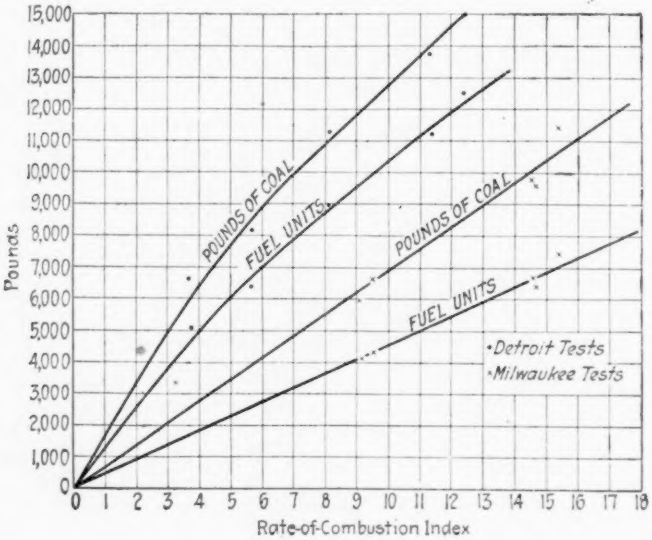

Fig. 3 Relation of Rate of Combustion to Combustion Index, ZCO_2

The loss of available heat up the chimney, as is shown by the tables and graphs, is due to three causes: excess air, excess temperature and CO. The components of this heat loss are shown by the tables and in Fig. 2. These losses can be quantitatively illustrated as shown in Fig. 4. The rectangle *ABCD* represents the total heat carried to waste by the dry gas, and *AGFE* the heat unavailable to the boiler. *EHJD* represents the loss of theoretically available heat due to excess air, *GIHF* that due to excess temperature and *IBCJ* to CO. Now supposing that the excess air had been increased so as to reduce the CO_2 to 10 per cent, the loss of available heat would have been increased by *DCLK;* assuming the temperature to remain the same and the percentage of CO also unchanged the loss due to the latter would be increased as shown by *CJML*. But supposing that the CO had been eliminated by this reduction in CO_2, the gain would have been 1.3 per cent and the loss 4.8 per cent, resulting in a net loss of 3.5 per cent. This is not the place to discuss this phase of the problem, except to call attention to the fact that care must be exercised in eliminating CO at the expense of CO_2, since the loss is liable by far to exceed the gain. Complete combustion is by no means synonymous with most efficient combustion. The greatest practical value of this method of control consists in its simplicity as well as its adequacy. Three autographic records preferably on the same chart are all that is required to furnish the necessary data. The calculations are of the simplest nature and the method is quite independent of the analysis of the coal and its variable heat-value as long as it is true bituminous coal, i.e., with oxygen within the limits of 3 to 12 per cent. The heat brought in by the air is contained in the unavailable heat, hence does not affect the reliability of the control. The loss of available heat is the only loss that need be considered because it is the only loss that is controllable. This method of control fixes the responsibility, inasmuch as it separates the heat loss into two parts, namely, combustion loss controllable by the fireman, and absorption loss controllable by the boiler cleaners.

This may be a bold statement considering the present general state of the art and science of boiler operation, but the author hopes and believes that this method of control is a step in the right direction. If it is not, he wants to be set straight; if the method is fallacious, this is the time and place to disprove the claim he makes for it. So far as the equicalorific fuel unit is concerned the author has no fear that it will be upset. There may be exceptional coals within the prescribed oxygen limits that will not come within the practically allowable limits of the equicalorific heating value, but there will be few if any. The average analysis of the coal used in the five Detroit tests varied 4.75 per cent in ash, 2 per cent in oxygen and 804 B.t.u. in heating value, while the separate analyses of the same coal varied as much as 1000 B.t.u.; whereas the variation in the heating value of the pound-carbon fuel unit as determined from the average analysis of the coal used in these tests differs from the equicalorific heating value by only 372 B.t.u. The heating value of the coal used in the five Milwaukee tests varied 834 B.t.u.; the oxygen not being given in the analysis, the variation in the pound-carbon fuel unit could not be determined, but as found from the analyses of representative samples of Illinois coal, the pound-carbon fuel unit is practically equicalorific. The highest heating value of the coal used in the Detroit tests was 14,493 B.t.u. and the lowest of that used in the Milwaukee tests was 11,483 B.t.u., a difference of over 3000 B.t.u., but, as we have seen, this difference in heating value per pound of coal does not affect the constancy of the equicalorific fuel unit nor the practicability of the heat-loss control formulas based thereon.

The author has placed emphasis on the necessity of getting the attitude of mind of the operating engineer in line with the endeavor of the Fuels Division to reduce the consumption of fuel in the production of steam to a minimum. To make worthwhile progress there must be coöperation from the fireman up to the owner or managing director of the steam-power-producing and coal-consuming plants. The urge for the necessary equipment should come from below and be granted from above. To this end education is necessary at the top and at the bottom as well as in between.

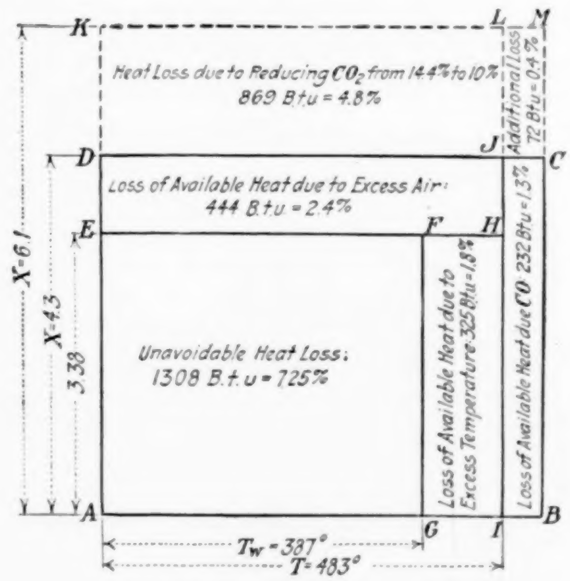

Fig. 4 Heat-Loss Diagram

The ten boiler tests illustrating the application of the author's control formulas show what can be accomplished in the way of economic boiler operation. The average efficiency of boilers in plants the country over is from 15 to 20 per cent below these high standards. The reasons for the slow progress, in the author's judgment, have been: (1) Lack of fundamental control principles which can be readily understood and easily applied by the operating engineer; (2) lack of knowledge and appreciation, by the owners and managers, of the preventable waste of fuel in their plants; (3) lack of coöperation between instrument maker and the purchaser of such instruments; (4) lack of equipment of the necessary instruments; and (5) last but not least, lack of proper instruction to enable the operating engineer to coördinate and interpret the information autographically recorded when such instruments are supplied.

Discussion

Nevin E. Funk[1] opened the discussion of Mr. Uehling's paper as follows: "In Par. 26 the author says: 'If the necessary equipment is provided, any up-to-date operating engineer should by the aid of such equipment and the simplified formulas be able to maintain the highest combustion and absorption efficiency that the structural and operating conditions of his plant (including the quality of the fuel used) will permit, and if maximum combustion and absorption efficiencies are maintained, minimum waste of fuel will necessarily result.'

"That can be done hour by hour or minute by minute by the use of the scheme he has outlined. Of course, it is of some value to know the next day what you have done, but it is far better to arrange the control equipment so that it is possible to know that the coal is burned efficiently at the moment of its burning, but the writer does not believe this scheme has done that.

"The author says: 'If the proper tools are supplied, maintaining absorption efficiency is a simple matter.' That is a very good statement. The writer cannot see, however, that Mr. Uehling has stated the proper tools in this paper. There is an attempt at a statement in another paragraph where the author says: 'in addition to the steam gage and water glass, which are always supplied (because required by law), the necessary instruments, viz., an Orsat, a continuous recording CO_2 meter and indicator, a recording pyrometer and a boiler draft gage have been properly installed.' These are the instruments he needs to check this boiler efficiency scheme. It will be noticed there is no output measurement on the boiler. If the operator does not know the output of the boiler, how does he know the correct draft? The results will be hit or miss. He guesses it by looking at the fire, and if there is more than one boiler, or if there are several men running a bank of boilers, there is a probability that one man may keep a splendid fire above and make the other fellow take the ragged ends, and so it seems that a very important instrument has been left out of Mr. Uehling's statement, that is, a steam-flow meter or a water-flow meter, either one, which shows at what output the boiler is delivering every instant.

"Then, to match up the readings of some of these meters, such as a draft gage, there must be a table on the boiler telling what the draft should be for each output, or some scheme should be used to give a man an indication of his performance during the period of the steam flow.

"These comments have been in a way destructive, but the writer does not want to leave the impression that he feels that this paper is not important, because he thinks it is. He does not believe that the method has given the means of putting in the operator's hands accurate control of good combustion."

A. T. Hutchins[1] presented a written discussion and a curve in which he had plotted gas analyses from the Detroit Edison Co.'s tests, the New York Edison Co.'s tests, and the formula proposed by Mr. Uehling.

F. G. Cutler[2] said that the author had overlooked one phase of the subject, that applied to steel-plant operation, particularly with blast-furnace or by-product gases. With by-product gas the best CO_2 content is around 7 per cent, he said, and with blast-furnace gas it is from 22 to 25 per cent.

[1] Operating Engr., Philadelphia Elec. Co., Philadelphia, Pa. Mem. Am. Soc.M.E.

[1] Supt. Steam Plants, Alabama Power Co., Birmingham, Ala. Mem. Am. Soc.M.E.

[2] Ch. of Bur. of Steam Engrg., Tenn. Coal, Iron & R.R. Co., Ensley, Ala. Mem. Am.Soc.M.E.

Steel for Forge Welding

By FRANK N. SPELLER,[1] PITTSBURGH, PA.

In this paper the principal factors—method of manufacture, chemical composition, fluxing quality, susceptibility to heat and welding temperature—affecting the welding quality of steel are discussed and the average results of 80 tests made on forge welds of hammer-welded pipe are compared with the original material. In addition it is stated that tests have demonstrated that both steel not over 0.15 per cent carbon and minimum tensile strength of 47,000 lb. per sq. in. and that not over 0.20 per cent carbon and minimum tensile strength of 52,000 lb. per sq. in., are satisfactory for forge welding of pipe lines, penstocks, tank-car work and similar construction. In conclusion the writer states that the most important considerations to produce uniformly good results in the forge welding of steel, are suitable material, well-trained operators and adequate facilities for the control of operations.

The welding quality of steel and the strength and reliability of such welds depend on a number of factors, which include principally method of manufacture, composition, susceptibility to heat, fluxing quality, the mechanical appliances for handling and controlling the work, and the skill of the operator. There are so many factors present affecting the results that it is often difficult to determine which of these predominates in any particular case. This paper discusses particularly the characteristics of steel for forge welding, with brief reference to other factors which enter the problem.

Material and Workmanship

Method of Manufacture. Wrought iron is most easily welded, probably on account of the presence of about one and one-half per cent of easily fusible cinder, which enables the metal to be welded at a comparatively low temperature and protects it from injurious oxidation at high temperature. For this reason wrought iron can usually be welded without much difficulty, but on account of the presence of this cinder internal defects such as laminations and blisters are more likely to occur after the metal has been brought up to the welding heat. What we term "soft welding steel" may be made by the bessemer or open-hearth process and should be made especially for this purpose, i.e., it should have, as far as possible, sufficient of the characteristics of wrought iron to readily form a "welding scale" at the lowest possible temperature. Very highly refined open-hearth steels, "ingot iron" or electric steel, are, as a rule, lacking in this respect and so far have not shown as good welding quality as soft welding steel or wrought iron.

Composition. It is well known that comparatively small quantities of nickel, chromium and silicon interfere seriously with welding. Each of these should be under 0.05 per cent. Carbon has a lesser effect and should preferably be low, certainly under 0.30 per cent for any kind of forge welding. The higher the carbon, the lower the melting and burning points of the steel. By the burning point we mean the temperature at which the grain growth has increased to such a degree as to cause actual disintegration and intergranular oxidation of the metal. Sulphur under 0.05 per cent is not harmful and under certain conditions more may be present without injurious results. Phosphorus up to bessemer limits is beneficial to welding.

Self-Fluxing Quality. On heating iron or steel above 1500 deg. fahr. an oxide scale is formed. The relation between the fusibility of the oxide scale to the temperature at which the metal "burns" is one of the most important factors determining suitability of the metal for welding. This scale consists usually of the magnetic oxide of iron (Fe_3O_4) with a certain percentage of "sonims"[1] from the iron (MnO, P_2O_5, SiO_2, etc.) which tend to make the scale more fusible. The method of manufacture and composition of the steel have much to do with the formation of a suitable welding scale.

[1] Metallurgical Engineer, National Tube Co. Mem. Am.Soc.M.E.

Abridgment of a paper presented at the Spring Meeting, Atlanta, Ga. May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Solid non-metallic impurities in steel, H. D. Hibbard, Trans. A.I.M.E., vol. xli, p. 803 (1910).

The range of temperature between the melting point of the scale and the burning point of the metal is about 100 deg. fahr. in good welding steel and distinguishes this class of steel probably more than any other property. In fact, it is this self-fluxing quality which makes possible the commercial welding of iron and steel. Artificial fluxes, such as borax, may be used to lower the melting point of the scale in welding small parts of high-carbon steel, but at present this is not practicable to apply satisfactorily when working on a large scale. The fusion of the scale also affords the operator a definite indication of the welding point, giving him close control over the operation.

Susceptibility of Metal to Heat. When normal wrought iron or steel is heated above the upper critical point (about 1750 deg. fahr. for soft steel) the grain grows at a rate depending on the temperature and time of heating. When a certain grain size is reached, a disintegration of the metal occurs with intergranular oxidation and the metal becomes "burnt." When this occurs, the metal is red-short and cold-short and useless for most purposes. The actual temperature at which iron or steel is burned depends as much on the protective character and fusibility of the welding scale as anything else. High-carbon steels are more susceptible to damage of this kind in welding than the same class of steel of lower carbon, but the carbon is not the only factor, otherwise we might expect highly refined open-hearth steel or "ingot iron" to weld as easily as charcoal iron.

The large granular structure caused by exposure of the metal to welding temperature may be reduced to a fine structure (unless the metal has been excessively overheated) by a certain amount of mechanical forging applied while the metal is cooling or by reheating the metal to about 30 deg. fahr. above the upper critical point, followed by cooling in the air, which with soft steel may be comparatively rapid.

Welding Temperature. To produce intercrystalline union of two pieces of iron it is necessary that the clean surfaces be brought into close contact with a certain pressure. This is possible even at normal temperature with application of sufficient pressure in the case of soft steel, or may easily be done at a temperature slightly above the fusing point of the scale with comparatively little pressure, or at a lower temperature if the fusion point of the scale is lowered by the use of artificial fluxes, such as borax. So that the most favorable temperature for welding depends on the material and mechanical facilities. The usual temperature at which soft steel is found to weld satisfactorily ranges from 2500 to 2600 deg. fahr.

Results of Tests

A number of tests of forge welds (80 in all) made on two rings cut from the ends of hammer-welded pipe, compared with the original material taken from the same pipe, about 1/2 in. thick 90 deg. from the weld, gave results which are summarized as follows:

Material Away from Weld—Average transverse tensile test:	
Elastic limit, lb. per sq. in.	32150
Ultimate strength, lb. per sq. in.	52790
Elongation in 8 in., per cent	29.7
Reduction, per cent	58.6
Efficiency of Weld—Test pieces machined to uniform thickness:	
Average of all tests (80 tests), per cent	92.7
Average at extreme end (40 tests), per cent	90.3
Average 2 in. or more away from end (40 tests), per cent	95.0
Minimum at extreme end, per cent	69.0
Minimum 2 in. or more away from end, per cent	82.3

The above steel before welding ranged in tensile strength from about 47,000 to 62,000 lb. per sq. in.—most of it being under 57,000 lb. and under 0.16 per cent carbon.

Specifications

This brings us to the question of specifications for steel best suited for forge welding. While skillful operators can undoubtedly make a good job of most steels when the carbon does not exceed that of flange quality, it seems desirable, everything considered, to limit the carbon to about 0.15 per cent for important parts where life and valuable property are at stake and a high efficiency of strength of weld is desired.

The present A.S.T.M. specification (A78-21-T) for forge-welding steel (given in an appendix to the complete paper) calls for steel of not over 0.18 per cent carbon having a minimum tensile strength of 50,000 lb. per sq. in. A.S.T.M. Sub-Committee II of Committee A-1 now has under consideration substituting for this two grades of steel having the following chemical and physical properties:

Chemical Composition	Grade A	Grade B
Carbon, per cent[1]	not over 0.15	not over 0.20
Manganese, per cent	0.35 to 0.60	0.35 to 0.60
Phosphorus, per cent	0.04	0.04
Sulphur, per cent	0.05	0.05
Physical Tests		
Tensile strength, lb. per sq. in.	not under 47,000	not under 52,000
Yield point, lb. per sq. in.	not under 25,000	0.5 tensile strength
Elongation in 8 in., per cent	not under 26	not under 24

[1] For plates over 3/4 in. thick, 0.02 additional carbon is permissible.

Steel of both grades has been forge-welded and used in large quantities with an assumed weld efficiency of 90 per cent. The tests we have made indicate that this figure is warranted for pipe lines, penstocks, tank-car work and similar construction. A somewhat lower efficiency or higher factor of safety should, of course, be used for boilers and Class A unfired pressure vessels.

Boiler-Code Requirements

With respect to steel for forge welding, Part I, Section I, Par. 186 of the A.S.M.E. Boiler Code requires that:

> The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 47,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

Section III, Par. L-29 reads:

> The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 45,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

The proposed section on unfired pressure vessels with reference to forge weldings, Pars. 5 and 8, reads:

> The ultimate strength of a joint which has been properly welded by the forge process shall be taken as 65 per cent of the tensile strength of the plate.

This weld efficiency seems rather low for Class A vessels and we believe that it should be still higher for Class B vessels.

In Pars. 2 and 3 of Sections I and III, firebox and flange steel are specified *for all parts* of the boiler. There seems to be a conflict in these specifications between the requirements for steel which may be forge-welded, although apparently the intention is to use a steel of lower carbon for this purpose. This would seem to be in line with the best experience, but inasmuch as flange steel has apparently been successfully used for some time in forge-welded boiler construction where part of the stress is carried by riveted straps, there would seem to be no reason for not continuing this practice when the weld is so reinforced.

Finishing

After the weld is made, internal strains remain in the metal which should be released by annealing. This may be done by heating the piece uniformly to a red heat (about 1500 deg. fahr.) and allowing to cool in the air. Any objectionable amount of distortion which has occurred in the welding operation should be removed, preferably while the piece is at an annealing heat; otherwise it should be reformed and then annealed. Some operators prefer one form of scarfing, others none at all. Some use roller welding machines, but the majority use power hammers.[1] Good welding has been done with coke fire, producer gas, natural gas and water gas, the last being best adapted for forge welding on a large scale.

To produce uniformly a high weld efficiency the most important considerations are suitable material, well-trained operators, and adequate facilities for control of the work.

[1] Details of mechanical appliances for hammer welding in modern American plants will be found in articles by E. F. Thum in *Chemical & Metallurgical Engineering*, September 21, 1921, October 19, 1921, and November 16, 1921.

The Evaporation of a Liquid into a Gas

By W. K. Lewis,[1] Cambridge, Mass.

The author investigates the mechanism of the evaporation of a liquid into a gas as applied to such processes as are found in gas scrubbers, humidifiers, dehumidifiers, water coolers, air driers, etc. He establishes a formula for calculating the humidity of air from wet- and dry-bulb thermometer readings, and shows that the coefficient of heat transfer divided by the coefficient of diffusion equals the humid heat of the gas.

A large amount of work has been done on the evaporation of water into air at temperatures below the boiling point. The dynamic equilibrium corresponding to the evaporation of water into air counterbalanced by the flow of heat from the air into the water is the basis of wet-bulb thermometry, the most useful method of determining the humidity of air.[2] In 1886 Desmond Fitzgerald[3] pointed out that the rate of evaporation of water into air is a function of the difference in partial pressure between the moisture in equilibrium with the evaporating water and the actual moisture content of the air in contact with it. It is true that Fitzgerald did not assume the rate of evaporation linearly proportional to this difference, but added a small correction term proportional to the square of the difference. Barrows and Babb[4] made a large number of determinations of evaporation from the surface of Maine lakes, and while their experimental determinations were subject to a large percentage variation, none the less their results substantiate this proportionality. More recently Willis H. Carrier[5] has shown that the rate of water evaporation is, within experimental error, proportional to partial-pressure difference. The following is an analysis of the mechanism of such evaporation.

Preliminary Assumptions

For purposes of formula derivation assume a long tunnel through which unsaturated air is flowing at constant mass velocity. The walls of this tunnel are non-conductors of heat. Along the bottom of the tunnel is placed a mat or wick permanently wet with water supplied from below as evaporation takes place above. The water is furnished to this wick at every point at a temperature exactly equal to that of the water on the upper surface of the wick at that point. There is no motion of the liquid water parallel to the axis of the tunnel. The mass velocity of the air over the water is constant and sufficiently low so that heat generated by friction may be neglected.

The unsaturated air entering this tunnel will become humidified in passing through it owing to the evaporation of water. In consequence, the temperature of the air will fall, and if the tunnel be sufficiently long, the water and air will ultimately come to equilibrium.

Notation

In the formula to be derived, the following notation is used:

A = Area of liquid in contact with gas

H = Absolute humidity of gas, or parts by weight of vapor per part by weight of vapor free gas

h = Surface coefficient of conductivity of heat between gas and liquid, or B.t.u. per unit time per unit surface area per unit temperature difference

k' = Coefficient of diffusion, or parts by weight of vapor diffused per unit time per unit area per unit absolute humidity difference

k = Coefficient of diffusion, or parts by weight of vapor diffused per unit time per unit area per unit vapor pressure difference

p = Partial pressure of vapor

P = Total pressure of vapor and vapor-free gas (i.e., barometer)

θ = Time

t = Temperature

r = Latent heat of vaporization

s = Humid heat, or number of heat units necessary to change the temperature of unit weight of vapor-free gas, *plus the vapor it contains*, one degree

W = Weight of liquid evaporated.

Interaction of Water with Air

Now consider for the moment the conditions at any given point along the length of this tunnel. At this point the temperature, absolute humidity, and pressure of water vapor in the air will be represented by t, H and p. Since the apparatus is continuous in its operation these conditions will remain unchanged at this particular point, but will vary from point to point along the tunnel. The corresponding quantities representing the condition of the liquid water in contact with the air at this particular point are t_w, H_w and p_w.

The mechanism of interaction of the water with the air is as follows: There exists over the water what is equivalent to a stationary film of air, which insulates the water from the main body of the air. Through this air film heat is diffusing from the air into the water and through the same film there is diffusing, in the opposite direction, the water vapor formed by evaporation on the surface of the liquid. This evaporation cools the surface of water, and, since it is available from no other source, heat must be supplied solely by diffusion from the air. The heat of vaporization must therefore be quantitatively compensated by the heat flow through the surface film, and the rate of evaporation is limited by the rate of diffusion of vapor through the same film.

From the foregoing one can immediately write the following equations:

$$-\frac{dW}{Ad\theta} = k'(p_w - p) \qquad [1]$$

$$\frac{dQ}{Ad\theta} = h(t - t_w) \qquad [2]$$

$$dQ = -r_w dW \qquad [3]$$

Whence

$$p_w - p = \frac{h}{k'r_w}(t - t_w) \qquad [4]$$

This last equation is the one normally used for calculating the humidity of air from wet- and dry-bulb thermometer readings. In it, variation in r_w is neglected and the term $h/k'r_w$ is assumed constant. For p in millimeters of mercury and t in deg. cent., it equals 0.5. The equation implicitly assumes that the cooling of the air is differential, i.e., so small in the neighborhood of the point in question that the actual changes in temperature and humidity of the air, t and p (or H), are negligible.

Since

$$p = P\frac{\frac{H}{18}}{\frac{H}{18} + \frac{1}{29}} \qquad [5]$$

$$t - t_w = \frac{k'r_w}{h}P\left(\frac{\frac{H_w}{18}}{\frac{H_w}{18} + \frac{1}{29}} - \frac{\frac{H}{18}}{\frac{H}{18} + \frac{1}{29}}\right) \qquad [6]$$

Where H is small, as is usually the case below 150 deg. fahr., $\frac{H_w}{18}$

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[1] Head of Dept. of Chem. Engrg., Mass. Inst. of Tech.

[2] Leslie, Nicholson's Journal, vol. 3, p. 461; August, Pogg. Ann., vol. 5, p. 69, 1825; Apjohn, Trans. Royal Irish Acad., vol. 17, p. 275, 1834; Weilenmann, Meteorol. Zeit., vol. 12, pp. 268 and 368, 1877; Maxwell, Zeit. f. Meteorol., vol. 16, p. 177, 1881; O. D. Chowolson, Traité de Physique, vol. 3, part 3, p. 807, 1911.

[3] Journal Am.Soc.C.E., 1886.

[4] U. S. Dept. of Interior, Washington, D. C., Water Supply Bulletin No. 279.

[5] Am. Soc. Refrigerating Engineers' Journal, May, 1916, vol. 2, no. 6, p. 25.

Paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

and $\frac{H}{18}$ are negligible compared with $\frac{1}{29}$, and one may write, as a close approximation,

$$t - t_w = \frac{kr_w}{h}(H_w - H) \quad [7]$$

where $$k = 29k' \frac{P}{18}$$

It is obvious that h and k depend on the thickness of the air film and are therefore functions of the velocity of the air. It is, however, equally obvious that if air velocity be increased sufficiently to double the one, the other will double also. The ratio of h/k therefore remains constant, independent of velocity. This explains why the reading of a wet-bulb thermometer is uninfluenced by the velocity of air passing it, provided the velocity is sufficient so that any heat lost by radiation is negligible in comparison with that picked up by conduction.

The Relation $h/k = s$

Now consider the change in humidity and temperature of the air as it moves along the tunnel. Starting at the same point previously considered, the air will drop in temperature by an amount dt and increase in humidity by an amount dH. The heat given up by cooling must correspond to the heat of vaporization of the water picked up, i.e.,

$$-sdt = r_w dH \quad [8]$$

whence, assuming constancy of s and r_w,

$$H = -\frac{s}{r_w}t + \text{const.} \quad [9]$$

Assuming the tunnel indefinitely long, the air will ultimately become saturated at some temperature t_e, and humidity H_e. Since these conditions represent equilibrium between the air and the water, evaporation will cease, and t_e and H_e are therefore the constant, fixed end-points of the process. Inserting these limits,

$$H_e - H = \frac{s}{r_w}(t - t_e).$$

We have now derived two formulas connecting H and t, both applying to this same process of evaporation, i.e.,

$$H_e - H = \frac{s}{r_w}(t - t_e)$$

and

$$H_w - H = \frac{h}{kr_w}(t - t_w)$$

These two expressions must therefore be identical. By the method of undetermined coefficients this can be true only provided the corresponding coefficients are equal, i.e.,

$$\frac{s}{r_w} = \frac{h}{kr_w}, \text{ or } s = \frac{h}{k}$$

and $t_w = t_e$, a constant; and $H_w = H_e$, also constant.

So far the discussion has been limited to water and air. Obviously, however, the same relationships must apply to any liquid and any gas with which its vapor is mixed.

The first of these equations, $h/k = s$, states that the coefficient of heat transfer divided by the coefficient of vapor diffusion through the gas film is constant, and equal to the humid heat of the gas. By means of Formula [4] the ratio h/k can be calculated from the observed wet- and dry-bulb temperatures for any vapor-gas mixture of a known gas humidity. The experimental determinations of wet-bulb temperatures for water-air, water-carbon dioxide, toluol-air and chlorbenzol-air, and calculations for h/k given in Table 1

TABLE 1 VALUES OF h/k FOR VARIOUS VAPOR-GAS MIXTURES

	h/k calculated from experimental results	Specific heat of gas
Water-air	0.236	0.238
Water-carbon dioxide	0.217	0.220
Toluol-air	0.238	0.238
Chlorbenzol-air	0.248	0.238

show that this ratio is in all cases substantially equal to the humid heat of the entering gas, which in this case was identical with the specific heat because the gas which was used was vapor free.

We have therefore demonstrated that, granting substantial constancy of s and r_w, and assuming H to be small, the ratio of the coefficient of diffusion of heat to that of any vapor through the gas film on the surface of the liquid is equal to the "humid" heat of the gas. Furthermore, during "adiabatic"[1] evaporation of a liquid into a gas, the liquid being in dynamic equilibrium with the gas, the temperature of the liquid remains unchanged throughout the process and the end-point of the process is reached when the gas has cooled itself to saturation at a temperature identical with that of an ordinary wet-bulb thermometer.[2]

Importance of the Relationship $h/k = s$

The importance of the relationship $h/k = s$ is very great. The term s, the humid heat, may be readily calculated for any case, regardless of whether the problem is primarily one of heat transfer or of diffusion. Hence if the heat-transfer coefficient h has been experimentally determined for a certain type of apparatus operating under definite conditions, the coefficient of diffusion equals h/s, and the capacity of this same apparatus may be predicted when functioning in diffusion processes, e.g., as a gas scrubber. Conversely, if k and s are known for definite conditions, h equals ks; in other words, one can predict the performance of a given apparatus for heat transfer from data upon the same equipment functioning as a scrubber.

These processes of diffusion of heat and of vapor are at the basis of the performance of all such equipment as humidifiers, dehumidifiers, water coolers, gas scrubbers, air driers, light oil stripping columns, and the like. The above relationships make it possible to study the performance of such equipment on a more rational basis than hitherto and to compare the effectiveness of different types of equipment even when the data on the individual types are obtained under widely varying conditions. The Department of Chemical Engineering, Massachusetts Institute of Technology, expects to publish in the near future a series of articles showing various applications of these relations.

Occlusion of Gases in Coal

The great trouble about the analysis of coal and the estimates based upon the analysis is that the analytical processes themselves affect the coal so that the methods of examination are conventional. That concerns the very first quantity determined in any analysis, the moisture, and further, the volatile constituents and the occluded gases. The occluded gases can be determined by pumping off the gas liberated, or by collecting the gas given off in a vacuum, either at ordinary temperature (15 deg. cent. or lower) or at 100 deg. cent. Especially at ordinary temperature the experiments will last many days, and there is evidence that the first liberation of the gas will be followed and accompanied by a reabsorption, and that the establishment of an equilibrium condition will be a slow process depending, among other conditions, on the diffusion of gas from the inner layers up into the first-evacuated surface layers of the coal. Conducting such experiments upon various coals and lignites occurring in New Zealand, A. D. Monro of Canterbury College, Christchurch, found that some of the coals behaved peculiarly. There would be strong spasmodic outbursts of gas, e.g., on the 7th, 22nd, 34th and 36th day, the evolution of gas stopping almost entirely on the intervening days, while in other cases the gas evolution would be much more steady. While the percentage of CO_2 in the gas evolved changed little during the outbursts, the percentage of nitrogen and, to a lesser degree that of oxygen, varied very much. Nitrogen and oxygen generally came off first from the various coals, carbon dioxide and methane more slowly. Most of the methane was liberated only by heating; in mines methane is, of course, slowly evolved without external heating, but the coal may be under considerable pressure and at relatively high temperature *in situ*. Monro suggests that gases are both mechanically retained, and held in solution, probably at considerable pressure; the latter would be more important and would account for the spasmodic outbursts. (*Journal Society of Chemical Industry*, April 29, pp. 129–132T)

[1] W. H. Carrier, Journal Am.Soc.M.E., 1912, p. 1321.
[2] Ibid.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Properties of Steam at High Pressures

By G. EICHELBERG

INVESTIGATION into the values of the heat of vaporization of steam. In particular, the author attempts to establish a relation between the exponents in the adiabatic equation, the heat of vaporization, and the specific heats of the steam, and measure indirectly the specific heats of saturated steam by using this relation.

The recent attempts to employ commercially steam pressures of the order of 60 atmos. makes it important to consider the behavior of steam at those pressures. Unfortunately, steam tables fail to agree for pressures in excess of 20 atmos. Because of this it was suggested that the measurements as to the heat of vaporization carried out by the German Institution for Physical and Technical Measurements be extended into this region of values, and this was actually done by Schuele in 1921. The results obtained by him were very different from those previously secured by the present author. At about 20 atmos. there is a difference in the values of the heat of vaporization as found by the two investigators of about 6 large calories, and at about 40 atmos. the difference is 19 large calories. Corresponding differences would of course appear also in the values for saturation volumes of steam as these are connected by thermodynamic laws with the values for the heat of vaporization.

It is claimed, however, that the measurements of specific heat in the region of superheat which Schuele had available, extended only up to 8 atmos. On the other hand, Eichelberg bases his values on the Munich measurements of the specific heats of superheated steam. These values were expressed in the form of an equation from which the various magnitudes of state in the region of superheat could be derived, one after another, in accordance with well-known thermodynamic laws. Furthermore, by means of the equation for the specific heats of water (Knoblauch and Winkhaus) and the condition of equilibrium between steam and water, it became possible to obtain the curve of vapor tension and finally all the magnitudes of state in the region of saturation, in particular, the values of the heat of vaporization.

These latter in the region above 10 atmos. have shown material deviations from the values obtained by Schuele and only further experimentation can show which are correct. Meanwhile, and having regard to the measurement of the specific heats of steam, there are two ways to which to proceed in forming an opinion.

The first of these is based on the variation of the heat content in cases of high superheat and requires that at equal temperatures the heat content shall decrease with increase in pressure. Since the specific volume of steam is smaller than it should have been according to the gas law, but with increase of superheat approaches it asymptotically (in other words, since in the equation $v = \frac{RT}{p} - \Delta$ the member Δ has a negative sign and converges toward zero, so that $\Delta > 0$ and $\left(\frac{\partial \Delta}{\partial T}\right)_p < 0$, it follows that—

$$\left(\frac{\partial i}{\partial p}\right)_T = A\left[v - T\left(\frac{\partial v}{\partial T}\right)_p\right] = A\left[-\Delta + T\left(\frac{\partial \Delta}{\partial T}\right)_p\right] \quad [1]$$

is always negative.

But the heat content i of steam consists of the heat content i' of the liquid, the heat of vaporization r and the heat of superheat i'', and because of this the variation of r may be tested by taking into consideration the requirement that i must decrease at equal temperature with increase in pressure.

In Table 1 i has been computed for $t = 550$ deg. cent. as the sum of the three magnitudes above referred to with the Schuele values for the heat of vaporization. After a brief falling off in the value of i, it appears that from 6 atmos. up (Fig. 4) there is a rise in value, in contradiction to the condition established above. As the Eichelberg values are derived directly from an equation for i and the values of r are calculated therefrom, the contradiction (lines 5 and 6) does not appear in this case.

Up to 10 atmos. there are available satisfactory measurements of

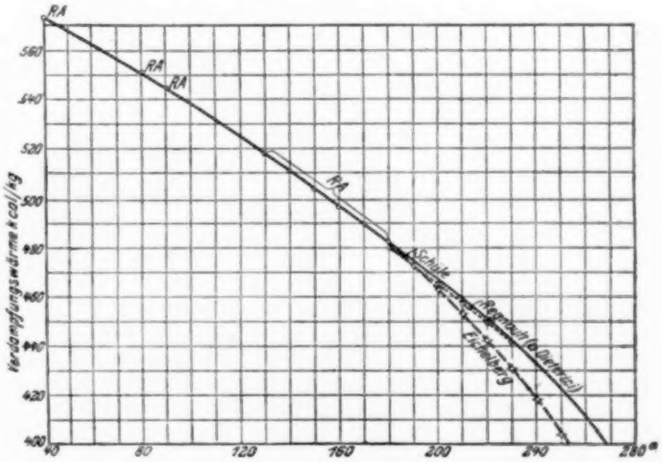

Fig. 1 Heats of Vaporization (Ordinates Are Heats of Vaporization in Large Calories per Kilogram; Abscissas are Temperatures in Deg. Cent.)

the heat of vaporization (Henning) expressed by an equation proposed by Thiesen (line 7). Within the range to which these measurements apply the three sets of values are in good accord. As it is unlikely that there is an error in i'', it follows that one of the two magnitudes is too large; namely, either the heat of vaporization r as found by Schuele, or the heat of superheat i_u at 20 atmos. the value of error being about four large calories.

To ascribe such an error to the value of the heat of superheat would mean, however, that the c_p curve for $p = 20$ atmos., which has been found by careful experiments, must be so displaced as to fall under the present curve for $p = 18$ atmos. without displacing at the same time the corresponding curve for $p = 8$ atmos. This again would mean that in the neighborhood of the limit of saturation the values for c_p at 20 atmos. must be located at least 10 per cent lower, somewhere as indicated by the broken line in Fig. 2. Notwithstanding the difficulty of measuring c_p, however, one would

TABLE 1 HEATS OF VAPORIZATION AND HEAT CONTENTS

p (atmospheres) =	2	4	6	8	10	12	14	16	18	20
1 Heat content of water i'	119.9	143.9	159.4	171.4	181.4	189.9	197.3	204.1	210.2	215.9
2 Heat of superheat i_u (550 deg. cent.)	211.0	202.6	197.8	194.5	192.0	190.4	188.9	187.8	187.0	186.5
3 Heat of vaporization r according to Schuele	525.7	508.7	498.0	489.7	482.6	476.9	471.4	466.6	461.8	457.4
4 Heat content at 550 deg. cent. with r according to Schuele	856.6	855.2	855.2	855.6	856.0	857.1	857.6	858.5	859.0	859.8
5 Heat content at 550 deg. cent. according to Eichelberg	856.8	856.4	856.0	855.6	855.2	854.9	854.5	854.1	853.7	853.3
6 Heat of vaporization r according to Eichelberg	525.9	509.9	498.8	489.7	481.8	474.7	468.3	462.2	456.5	450.9
7 Heat of vaporization r according to Thiesen	525.6	509.7	498.4	489.6	481.9	(475.3)	(469.2)	(463.7)	(458.6)	(453.8)

not expect to find such an error in the classical Munich measurements, which would lead to the belief that the Schuele heats of vaporization obtained by extrapolation based on insufficient experimental values are too high even for 20 atmos. In this connection the author states that Professor Knoblauch, one of those in charge of the Munich tests, assured him that it is inconceivable that the curve for 20 atmos. could, as shown in Fig. 2, be shifted so to appear below the curve for 18 atmos.

The second method of procedure mentioned by the author is of great interest, though not equally compelling. It is based on the slight variations (observed many times before) of the exponent of the adiabatic equation.

The exponent K_s = constant in the adiabatic equation $pv^K = C$ is

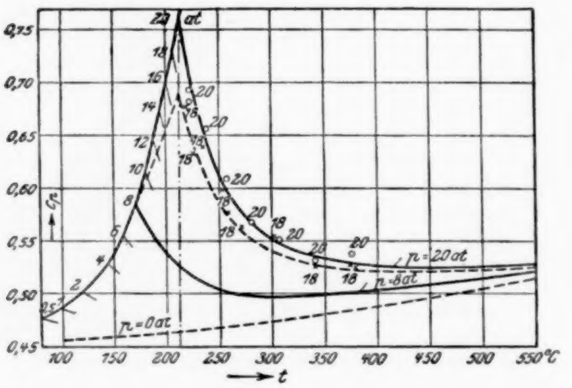

Fig. 2 Specific Heats c_p (At. = Atmospheres; Abscissas in Deg. Cent.)

the product of the exponent of the isothermal equation K_T = constant and the ratio c_p/c_v of the specific heats. It is identical with these latter only in the case of ideal gases, where $K_T = 1$. In the case of steam K_T beginning with the value 1 for $p = 0$, it decreases as we move along the limit of saturation, and at the critical point where $\left(\frac{\partial v}{\partial p}\right) = \infty$ it reaches the value—

$$K_T = -\frac{v}{p\left(\frac{\partial v}{\partial p}\right)_T} = 0$$

Since at the same point $\frac{c_p}{c_v} = \infty$, the value of K_T which it assumes at that critical point is indeterminate.

Numerical solution of the equation for c_p gives Table 2 and Fig. 3, which between them indicate that K_s has a nearly constant value of 1.3. This value has long been used for steam. A similar constancy of value has been observed with respect to the exponent n in the equation T = constant p^n, and this relation permits the following insight into the courses of variation of the heat of vaporization.

TABLE 2 EXPONENTS OF THE ISOTHERMAL AND ADIABATIC EQUATIONS (ALONG THE LIMIT OF SATURATION)

	K_T	$\frac{c_p}{c_v}$	K_s
$p = 2$	0.977	1.342	1.311
$p = 6$	0.947	1.382	1.310
$p = 10$	0.919	1.420	1.307
$p = 14$	0.891	1.466	1.305
$p = 20$	0.849	1.535	1.303

From the relation

$$\frac{r}{T} = s'' - s' \quad \text{[2]}$$

when

$$ds = \frac{c_p}{T}dT - A\left(\frac{\partial v}{\partial T}\right)_p dp \quad \text{[3]}$$

it follows that

$$\frac{d\left(\frac{r}{T}\right)}{dT} = \frac{c_p}{T} - A\left(\frac{\partial v}{\partial T}\right)\frac{dp_s}{dT} - \frac{c_{fl}}{T} \quad \text{[4]}$$

provided c_{fl} denotes the specific heat of water along the limit of saturation, and all the other magnitudes in the equation likewise refer to the limit of saturation. On the other hand, however, the exponent n may be expressed as follows:

$$n = \frac{Ap}{c_p}\left(\frac{\partial v}{\partial T}\right)_p \quad \text{[5]}$$

If now, from Equations [4] and [5] we eliminate the expression $\left(\frac{\partial v}{\partial T}\right)_p$ which is difficult to determine, we obtain—

$$c_p'' = \frac{T\frac{d\left(\frac{r}{T}\right)}{dT} + c_{fl}}{1 - n\frac{T}{p}\frac{dp_s}{dT}} \quad \text{[6]}$$

or

$$n = \left[1 - \frac{T\frac{d\left(\frac{r}{T}\right)}{dT} + c_{fl}}{c_p''}\right]\frac{1}{\frac{T}{p}\frac{dp_s}{dT}} \quad \text{[7]}$$

In this thermodynamically well-founded equation the following

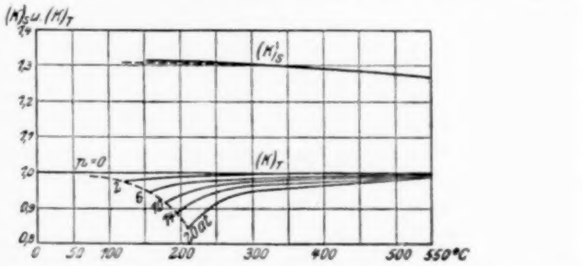

Fig. 3 Specific Heats c_p (At. = Atmospheres; Abscissas in Deg. Cent.)

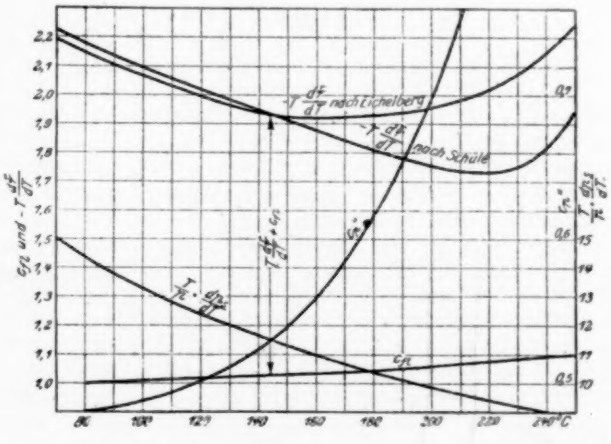

Fig. 4 Auxiliary Curves for Determining the Exponent n (*Und* = and; *nach* = according to.)

magnitudes may be considered as known with a great degree of reliability: $\frac{dp_s}{dT}$, the tangent of the steam-pressure curve up to the critical point; c_{fl}, the specific heat along the limit of liquefaction (up to about 300 deg. cent.), and likewise c_p'', the specific heat at constant pressure at the limit (up to 20 atmos.).

The magnitude $\frac{d\left(\frac{r}{T}\right)}{dT}$, or the inclination of the r curve, is subject to discussion, and with this in view the course of variation of n as found from Equation [7] may be examined.

Table 3 and Fig. 4 furnish the auxiliary magnitudes necessary to compute n; likewise from Fig. 4 the numerator $T\frac{d\left(\frac{r}{T}\right)}{dT} - c_{fl}$

TABLE 3 DETERMINATION OF EXPONENT n

t_s (deg. cent.) =	80	100	120	140	160	180	200	210
1 c_p'	1.00	1.01	1.02	1.02	1.03	1.05	1.06	1.07
2 c''_p	0.48	0.49	0.05	0.52	0.56	0.615	0.70	0.75
3 $\frac{T}{p}\frac{dp_s}{dT}$	14.4	13.3	12.4	11.7	11.0	10.4	9.9	9.65
4 $T\frac{d\left(\frac{r}{T}\right)}{dT}$ according to Eichelberg	−2.15	−2.07	−2.00	−1.94	−1.92	−1.93	−1.955	−1.98
5 $T\frac{d\left(\frac{r}{T}\right)}{dT}$ according to Schuele	−2.17	−2.09	−2.01	−1.94	−1.87	−1.80	−1.76	−1.73
6 Exponent n according to Eichelberg	0.236	0.237	0.238	0.237	0.235	0.234	0.231	0.229
7 Exponent n according to Schuele	0.239	0.240	0.240	0.237	0.227	0.214	0.202	0.195

may be read off as the distance between the two curves. The exponent n (lines 6 and 7 in Table 3) is plotted in Fig. 4 on a large scale. For purposes of comparison the exponent $\frac{K_s - 1}{K_s}$ as given by Table 2 is also plotted in broken lines.

The values of the exponent n computed by means of the values of r obtained by Eichelberg coincide on the whole with the $\frac{K_s - 1}{K_s}$ values, which was to be expected, as K_s and r are both derived from the same c_p equation. All the values of n lie between 0.23 and 0.24, which is in good agreement with the values determined by Hirn and Cazin in exhaust tests, namely, $n = 0.236$.

On the other hand, Schuele's values of r lead to an exponent which lies within the same limits up to 150 deg. cent., but which at 140

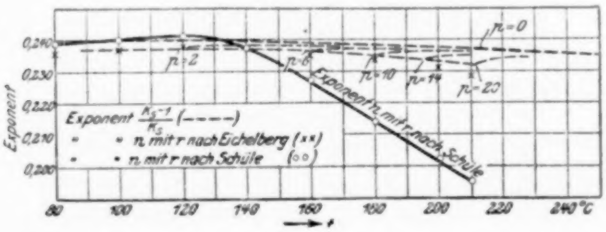

FIG. 5 EXPONENT n IN THE ADIABATIC EQUATION $T = p^n$
(*mit r nach* = with the values of r as determined by.)

deg. deviates from the original direction and at about 210 deg. cent. (which corresponds to about 20 atmos.) falls under 0.200, which would correspond to an exponent $K_s = 1.25$. All observations on steam as well as other vapors would, however, indicate the possibility of only a slight variation of the exponent. If the exponent be assumed to have a value between 0.23 and 0.24 for pressures of the order of 20 atmos. and if this should be confirmed by test, it would be obviously necessary to recognize that values of r which give contradictory results are incorrect. Since Equation [7] appears to be rational, and the error cannot be looked for in the other magnitudes besides r involved in the equation, the same statement would apply for c_p'' with the indicated values of r: it would be incorrect to the extent of 0.2 large calories, or, say, 30 per cent.

Finally, attention may be called to the fact that the comparatively sharp inflection in the course of variation of the heats of vaporization as shown in Fig. 1 is per se quite natural, as has been already recognized by Schuele. If, for purposes of comparison, one should plot the heats of vaporization r of various materials with the values of T/T_{crit} the curves obtained thereby would in many instances show an approximate proportionality. In Fig. 6 such a comparison is made for water, carbon dioxide, and ammonia. The latter two curves follow quite closely Eichelberg's r curve which, however, does not mean anything beyond proving once more that Eichelberg's r curve for steam has a rational basis. Such an analogy of curves, on the one hand, does not constitute a positive proof any more than does a comparison of the exponents of the adiabatic equations, at least so long as nothing more certain is known about these latter. On the other hand, however, according

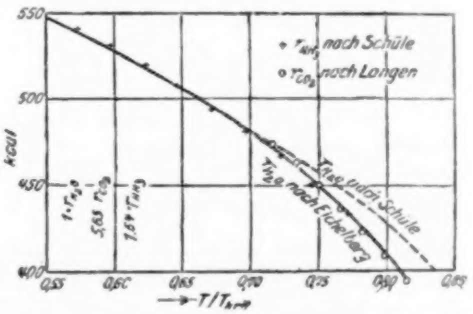

FIG. 6 COMPARISON OF HEATS OF VAPORIZATION OF WATER, CARBON DIOXIDE AND AMMONIA
($K\,cal$ = large calories; *nach* = according to.)

to the first criterion indicated above, it is certain that the values of the heat of vaporization extrapolated by Schuele are in conflict with the Munich measurements of specific heats of superheated steam between 10 and 20 atmos.

It would be very desirable to have this matter cleared up by further experiments. Much would be achieved if only the exponents of the adiabatic equation could be measured at 20 atmos. pressure and saturation, which could be done either by the Hirn and Cazin method or by measuring the velocity of sound in the corresponding medium. For the region above 20 atmos. the precise measurement of r would be of particular interest, together with the measurement of the exponent n or K_s, since then by means of Equation [6] one could obtain very reliable values of the specific heats c_p along the limiting curve which it has been impossible hitherto to obtain by any other method of measurement. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, no. 12, Mar. 25, 1922, pp. 275–277, 6 figs., *tA*)

Developments in Power-Station Design

ACCORDING to a report issued by the Electricity Commissioners (England), electric power is generated very cheaply in the north of England and the most economical steam generating station is tha at Carville-on-Tyne. The design of this station involved the solutions of a number of new problems, because of the abnormal steam conditions chosen and a speed of 2400 r.p.m. with 10,000-kw. alternators, which at the time of the design of the station (1915) was unusual. The steam conditions specified were a steam pressure of 200 lb. per sq. in. at the stop valve and a total temperature of 650 deg. fahr. with the additional specification that the steam turbines should be capable of withstanding continuously a temperature of 700 deg. fahr.

The difficulties which had to be overcome in order to operate the turbines at an initial steam pressure of 650 deg. to 750 deg. fahr. were found to be due almost entirely to unequal heating and cooling when starting up and shutting down, and these difficulties were aggravated by the unequal coefficient of expansion of the materials used. On starting up a Parsons turbine from the cold condition, the shroud strip on the blading heats up more quickly than anything else and by its expansion spreads the blades fanwise, the greatest bending stresses being produced at the roots of the outermost blades of a segment or unit. On shutting down the machine, the shrouding strip cools down first, and owing to its contraction the blades are bent in the reverse direction. The greater the circumferential length of the blade segments, the more serious is the effect produced, and if this dilation is sufficiently great, ultimate fracture of the blades at the root is the inevitable result.

In the first of the five 10,000-kw. sets installed in the Carville station, "end-tightened" blade segments composed of manganese

copper and about 6 in. long were used in the high-pressure cast-steel cylinder. The difference in the coefficient of expansion between the dummy packing or the blading material and that of the cylinder and shaft led to trouble, and the sequence of events is shown in Fig. 1. The top left-hand diagram shows a ring of brass strip dummy packing originally calked in at the ordinary temperature of the surroundings in 6-in. segments. On starting up the turbine the brass expanded more than the casing, with the result that the strip was forced out of the groove at the weakest points, namely, at the butt joints *A*, *B*, *C*, etc., the effect being shown in the diagram, Fig. 1. On shutting down the turbine the brass strip cooled more rapidly than the casing, and owing to the larger

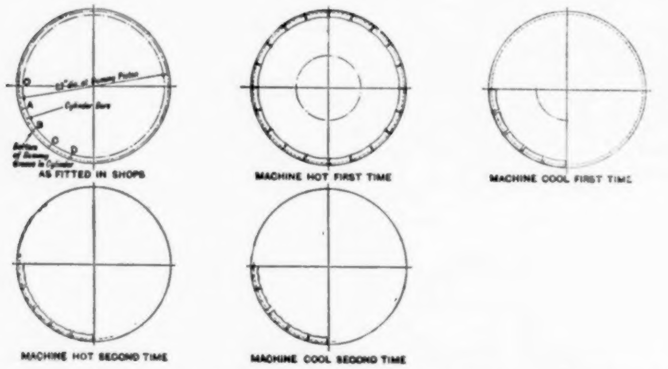

Fig. 1 Diagram Showing the Effects of Heating and Cooling in Steam Turbines

coefficient of expansion contracted to a greater extent, and definite gaps were left between the segments, as shown in the third diagram. The next time the turbine was started, however, the brass strip again heated up first and expanded more than the casing, and appeared to become so firmly wedged in the grooves that free expansion was restricted, with the result that hogging took place in the middle of the segments, as shown in the bottom left-hand diagram; while on cooling down the brass strip contracted freely and the gaps were widened still more, as shown in the next diagram.

The ultimate effect of these results was the formation of large

possible. The shrouding strip was kept the same length as the blade units, but small gaps were left between adjacent pieces. Dummy piston-packing strip was inserted in lengths of about 1 in., and proved to be entirely satisfactory. During the construction of the later machines for the Carville station further improvements were made.

Steel blade material was adopted, and the individual "lock root" type of blading was introduced into the shafts, each blade unit consisting of a blade and spacing section riveted and brazed together, the root being heavily serrated on both sides. The blade units were then assembled in grooves with parallel sides and with correspondingly heavy serrations, the last blades of each row being inserted through a lantern space, which was finally closed by a serrated steel locking piece calked in position with copper calking pieces. After being assembled into a complete blade ring in the shaft, the shroud strip was brazed on to the blade tenons in short lengths, the adjacent ends slightly overlapping so that in service flexibility is permitted without increasing the steam-leakage area. In the latest Parsons turbines the blade units are produced in one piece, a blade root and a spacing section being combined by a special process which does not involve expensive milling out of the solid nor casting the blades into the roots. The experience obtained at Carville has enabled perfect "end-tightened" reaction blading to be produced, and it is claimed to be quite suitable for the high steam temperatures which are now coming into use.

The success of the first Carville unit was such that several other similar sets were built. Recently two 10,000-kw. tandem machines of similar design, but without water-cooled rotors, and running at 3000 r.p.m. were installed and are run under the same steam conditions as those at Carville, and several other sets are either being installed or are under construction. It is of interest to note that while originally the specified steam temperature was 650 deg. fahr., this temperature was subsequently increased to 706 deg. fahr. owing to the efficiency of the superheaters and the absence of trouble with the turbines. The turbines are of the Parsons type.

The experience with these turbines has shown that when the electrical conditions permit, it is now easier and better to build a 15,000-kw. set for 3000 r.p.m. than for 1500 r.p.m.

One of the most recent turbine improvements is due to the Oerlikon Company, which has introduced a special method of

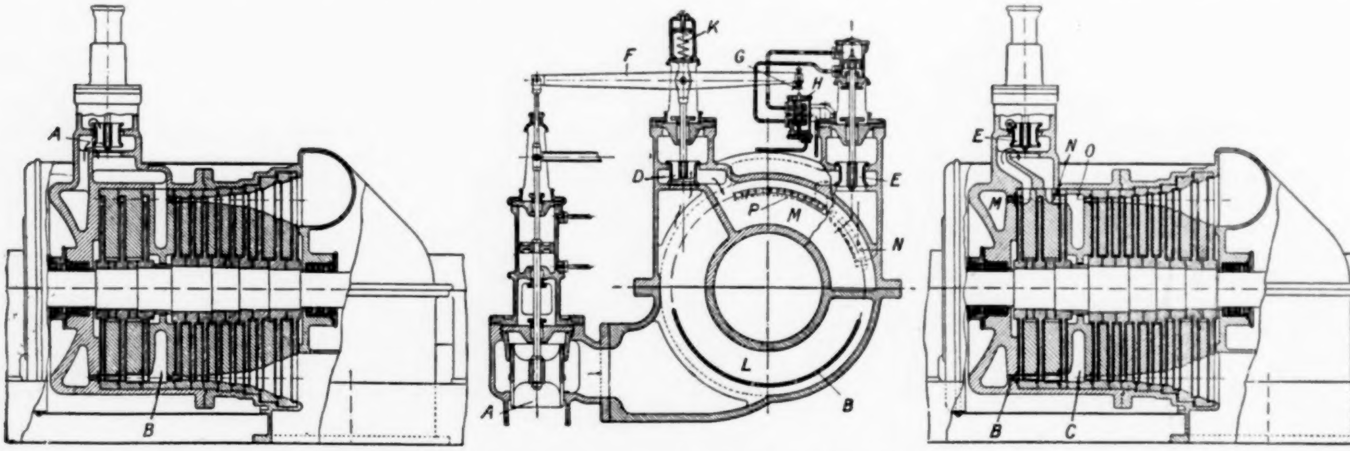

Fig. 2 Original Type of Oerlikon Turbine, and Fig. 3, New Type of Oerlikon Turbine

gaps between the segments, creeping of the segments in their grooves, so that in some cases they were butted close together with a corresponding large gap elsewhere, and general displacement out of the grooves. The cylinder blading behaved in a similar manner, while in the case of the rotating blade rings on the shaft the butted ends of the segments were forced outward, and the blades at the ends became loose. All these troubles were, however, largely overcome by the simple expedient of inserting both blade units and dummy packing strips in short lengths. In the case of the blading the segments were made about $1^1/_2$ times the length of the blades and they were also brazed up solid at the roots, which were accurately faced at the ends, so that creeping was made im-

admitting extra steam during times of overload. Steam turbines are usually required to deal with an overload of, say, 25 per cent for a specified period, which may range from one-half to two hours, and, generally speaking, the steam consumption while this overload is being carried exceeds that which is experienced while the machine is running at the normal full load for which it has been designed. The method of admitting the additional steam varies to a great extent in different makes of turbines. In the Oerlikon turbine, which has pressure stages, it was originally customary to introduce the overload steam into the second or one of the following stages, as shown in Fig. 2. Steam passed from the steam chest through the high-pressure section into the intermediate steam chamber

B, and from there into the low-pressure portion of the turbine, where there is full peripheral admission; while in the high-pressure portion there is only partial admission. At all loads up to full load the overload valve *A* remains closed, but when the load exceeds the full normal value the valve opens and admits steam to the low-pressure portion. A table is given in the paper which shows the increase in the steam consumption under overload conditions.

With the boiler plant available it was not possible to maintain the same steam conditions at all loads, the temperature of the steam in both the tests being higher during the overload tests than it was when the machines were running at other loads; but in arriving at the percentage increases given due allowance was made for that fact. Up to full load the steam consumption per kilowatt-hour decreases as the load increases, but after full load has been reached the consumption rises. Similarly, the efficiency of the turbo-generator increases up to full load and drops on overload. The steam consumption on overload is not of great importance when the overloads are infrequent and are of short duration, but in view of the fluctuations of load on the supply system, a turbine of the type shown—Fig. 2—would not, the makers contend, usually be worked at full load, as the variations in the load on the system would involve the by-pass valve being opened at fairly frequent intervals. Variations in steam pressure and vacuum have also to be taken into account, and the normal load under working conditions would hardly exceed 90 per cent of the full load. With the Oerlikon Company's patented arrangement for the admission of steam into turbines, however, the heat drop during the overload period can be entirely utilized. The steam passes from the main inlet valve into the throttle valve *A*—see Fig. 3—and the quantity of steam admitted to the turbine varies according to the load. The steam chest, as the drawing shows, occupies only a portion of the circumference, and the bank of nozzles *B* is designed to deal with the quantity of steam which the turbine requires for full load. This steam passes through the high-pressure part of the machine, which consists of three pressure stages, and flows into the intermediate steam chamber *C*, and from there into the low-pressure wheels, where there is full peripheral admission; while in the high-pressure part there is only partial admission. In the first and third stage of the turbine there is a separate bank of nozzles for the passage of the overload steam. As soon as the turbine is subjected to an overload and the normal supply of steam is no longer sufficient to enable the turbine to develop the output required, the two overload valves *D* and *E* open automatically. The central lever *F*, which is fitted with an adjustable screw *G*, opens the valve *E* by pressing on a pilot valve *H*, which causes the valve *E* to open by supplying oil under pressure to a piston. When the pilot valve has reached its lowest position the control lever *F* pivots about the screw *G*, and the overload valve *D*, which is normally held down by the spring *K*, is lifted. The additional steam passes from the steam chest *L* through the valve *D* into the steam chamber *M*, and from there it passes into the nozzle segments *P* and into the first turbine wheel. It is then led through the overload valve *E* to the nozzle segments *N* in the third stage of the turbine, and from there into the third set of wheels, where its energy is utilized. In the intermediate chamber *O* it joins the main supply of steam and flows through the low-pressure portion of the turbine.

The results obtained with this system of supplying extra overload steam to turbines have met all expectations. The fundamental difference between the old and new arrangements lies in the fact that in the latter case the efficiency steadily rises up to an overload of 140 per cent. Tests made on a 1500-kw. machine have also confirmed this result, and with this new arrangement for admitting overload steam it is not only possible to run the turbine at its full capacity, but also run it at overload for the full period as determined by the heating of the generator. In the case of back-pressure turbines working on overload the advantages of the new system of admitting overload steam are even greater than those which are obtained when the system is applied to ordinary turbines, as the total heat drop is smaller. All the Oerlikon turbines are now provided with this improved arrangement, and some of them are coupled to generators which are capable of carrying the overload continuously. (Serial article in *The Engineer*, vol. 133, no. 3459, Apr. 14, 1922, pp. 406–409, illustrated, *dgA*)

Short Abstracts of the Month

CONVEYING MACHINERY

Steel-Band Conveyors. Description of steel-band conveyors of the rolled linkless type as built by a German concern (Sandviken). This band is very thin (0.8 to 0.9 mm. or 0.031 to 0.035 in.) and consequently flexible. At the same time it is sufficiently stiff laterally to permit of spreading the material over a great width. The surface of the band is hardened to reduce wear. The end sheaves and supporting rollers may be made smaller than the width of the band; hence they may be made of large diameter, thus reducing the cost and power consumption.

The upper working strand of the band may be guided either on rollers or on slides. The lower strand is always supported on rollers. Graphite is usually used as a lubricant. Some data as to design are given in the original article. As regards drive, the steel-band conveyor does not essentially differ from other types. The speed of the band may vary from 60 to 90 m. (196 to 295 ft.) per min., depending upon the capacity.

It is claimed that such a steel band does not easily rust and that it is suitable for transport of wet material, such as clay, beet-root shavings, pulp, etc. When such sticky material is handled a special band cleaner is suspended above the lower strand near the end sheaf, pressing against the latter by means of springs. The original article illustrates the charging arrangements and also a unit used in a steel plant for transporting granulated blast-furnace slag and ore. (*Engineering Progress*, vol. 3, no. 5, pp. 109–110, 13 figs., *d*)

COMBUSTION ENGINES (See Marine Engineering)

ENGINEERING MATERIALS (See also Welding)

Synthetic and Electric-Furnace Cast Iron

Electric Cast Iron. Abstracts of four papers presented at a meeting of the American Electrochemical Society in Baltimore, April 27, 1922, and which cover the historical, economic, metallurgical and "sane" phases of the subject.

Geo. K. Elliott presented a paper on Cast Iron as Produced in Electric Furnaces. The first use of the electric furnace for gray cast iron in regular production seems to have been made by the Lunkenheimer Co., Cincinnati, Ohio, in the summer of 1917, the cupola being utilized in the melting period and the electric furnaces for refining.

The primary factor justifying the employment of the electric furnace as the second step in a duplexing process lies in its ability to refine and superheat the metal, two things which cannot be done in the cupola. On cast iron the electric furnace is capable of delivering without too great attention metal superheated to any degree, reduced in sulphur as required, deoxidized, and with carbon, silicon and manganese adjusted to the desired standards (this applies especially to the furnace with basic bottom). Phosphorus cannot be altered in cast iron by the electric furnace in commercial practice. The electric furnace is at its best when coupled with the chemical laboratory in an intimate manner.

The advantages of superheating lie in the increased fluidity of the iron. Greater fluidity not only permits the use of low-phosphorus iron, but in other metals assures solid castings through freedom from blow holes, shrink holes, slag inclusions and the like. Superheated metal increases the effectiveness of risers by lengthening the period of fluidity, which is their only period of activity as feeders, and thereby obviates to a large degree the internal shrinkage that comes from fluid contraction of the metal. Abetted by superhot metal the efficiency of the ordinary riser becomes surprising.

Jas. L. Cawthorn in a paper on Synthetic Cast Iron discussed methods of production of cast iron from machine-shop scrap. He stated that when this is melted in either an acid or basic electric furnace with 75 lb. of good coke per ton, it will come down with about 2.5 per cent carbon and well deoxidized. Melting under a carbide slag in a basic furnace does not change the carbon, man-

ganese or phosphorus, but reduces silicon practically to zero and sulphur to half. Acid-furnace melting without special slag, which is cheaper and simpler, brings down metal unchanged in sulphur and phosphorus; about 50 per cent of the manganese goes out in the slag and a little silicon may be picked up from the lining. If more carbon is needed it can be added by stirring it into hot, clean metal; for example, by poling, and the author described a useful test depending on the hardness of the test bar.

W. E. Moore gave a paper on History of Electric Cast-Iron Melting. The paper is, however, a good deal broader than its title.

It is stated that electric iron can be kept uniform in hardness and strength and under exact control for the particular application desired. The iron runs 50 to 90 per cent stronger than either cupola gray-iron castings or air-furnace malleable castings. Further, since electric iron may be rendered fluid by superheat, it is unnecessary to keep the phosphorus content high, low phosphorus adding to the resistance of the castings to shock.

In a case where the most careful cupola practice made bottle-machine molds which would hold their polish for four hours only, similar electric-furnace iron molds lasted from three to four times as long.

Table 1 was presented as giving the operating costs of iron furnaces. The figures of this table were, however, seriously questioned in the discussion. The electric furnace is said to offer superior metal for making white-iron castings to be malleableized or for making chilled castings, such as crusher wearing plates, chilled wheels, chilled rolls, etc. For electric iron castings charcoal pig may be eliminated entirely, with better results than before.

TABLE 1 OPERATING COSTS OF IRON FURNACES

	Cupola melting		3-Ton leectric furnace
Borings, 1500 lb. at \$4			\$ 3.00
Foundry pig, 1000 lb. at \$20	\$10.00		
Machinery scrap, 1000 lb. at \$14	7.00	500 lb.	3.50
Per ton mixture average	\$17.00		6.50
Melting loss, 8 per cent	1.36	4 per cent	0.68
	18.36		7.18
Coke, 1/6 ton at \$8	1.33	50 lb.	0.20
Blower power and slags	0.50		
Additions			0.20
Power, 400 kw-hr. at 1½ cents per kw-hr.			6.00
Electrodes, 10 lb. carbon at 6.5 cents			0.66
Refractory repairs	0.50		0.20
Labor	1.25		0.80
Total cost of iron "at spout"	\$21.94		\$15.24

In a paper entitled Synthetic and Electric Pig Iron Sanely Considered, Robt. Turnbull claimed that the manufacture of synthetic pig iron is a logical operation for iron foundries having electric furnaces and making either gray-iron or steel castings. In countries where coke is expensive, pig iron from scrap in an electric furnace may prove cheaper than electric-furnace production from ore.

The question of cost of production of cast iron in an electric furnace raised a lively discussion. E. L. Crosby told of a foundry in Detroit which could buy borings at \$8 per ton and use them for 100 per cent of the charge. The current consumption was 600 kw-hr. per ton under eight-hour operation, or 500 to 525 kw-hr. per ton for sixteen-hour operation. With current at 1.8 cents per kilowatt-hour, molten iron from borings cost \$23.60 per ton, whereas cupola iron made right alongside cost \$25.00 per ton, the number of rejections of castings being far less with electric iron than with cupola iron. On the other hand, the claim put forward by W. E. Moore that electric iron can be made at \$15 per ton was vigorously opposed by several speakers.

As part of the discussion Dr. Richard Moldenke read a translated abstract of an article from a German publication (*Giesserei-Zeitung*) describing the practice of a German foundry using the cupola-electric furnace duplexing process, and giving an itemized cost of operation in German units. (American Electrochemical Society papers abstracted through *The Iron Age*, vol. 109, no. 18, pp. 1203–1205, and *Chemical and Metallurgical Engineering*, vol. 26, no. 18, pp. 820–822, *gc*)

Cobalt-Tungsten Alloys, Karl Kreitz. Data of extensive experiments with alloys of these two metals, as a result of which experiments it was found that the alloys may be divided into five groups as follows: Those containing up to 40 per cent of tungsten have a mixed crystal structure; from 40 to 45 per cent tungsten, a eutectic matrix with primary mixed crystals; from 45 to 70 per cent tungsten the mixed crystals disappear and the crystals of a cobalt-tungsten combination take their place; from 70 to 80 per cent tungsten the alloys have an unstable structure, indicating the appearance of excess of tungsten; finally, alloys containing more than 80 per cent of tungsten, consisting of a homogeneous matrix embodying primary crystals, or possibly mixed crystals with a high content of tungsten.

From the investigation it would appear that only alloys containing about 10 per cent of tungsten may have a practical importance, for example, for use as a material for metal-cutting tools. The Brinell hardness varied from 185 to 282 with the increase of tungsten from 0 to 97 per cent, the variation being quite gradual. On the other hand, however, the increase of tungsten reduced the ability of the alloy to resist corrosion when in contact with sea water. (*Metall und Erz*, vol. 19, no. 6, Mar. 22, 1922, pp. 137–140, 1 fig., *e*)

Y Alloy (Aluminum-Copper-Nickel-Magnesium). Data on an alloy described in a recent report to the Alloys Research Committee of the British Institution of Mechanical Engineers, entitled Some Alloys of Aluminum.

The alloy contains about 4 per cent copper, 2 per cent nickel, 1.5 per cent magnesium and remainder aluminum. When properly cast and heat-treated it has a strength of 47,000 lb. per sq. in., and when rolled and heat-treated 54,500 lb. per sq. in., with an elongation of 24 per cent in 2 in.

The original article gives instructions as to the casting of this alloy. Its physical properties may be materially improved by heat treating. Chill castings are given a 6-hr. anneal at 530 deg. cent., then quenched in boiling water and aged. This treatment increases the tensile strength from 28,000 lb. to about 47,000 lb. per sq. in. with 6.5 per cent elongation in 2 in.

Data on correct forging and rolling practice and physical properties of rolled Y alloy after heat treatment are given in the original article. One of the remarkable properties of this alloy is its great resistance to corrosion, which is greater than that of high-strength aluminum alloys. (*Chemical and Metallurgical Engineering*, vol. 26, no. 17, Apr. 26, 1922, pp. 785–787, 6 figs., *de*)

FOUNDRY

Making Castings Without Feeding Heads. Abstracts of two articles, one in a British and the other an American publication. The first article reports the work of E. Ronceray, a French foundryman, who delivered a lecture at a meeting of the London section of the Institute of British Foundrymen, April 16, 1922.

The principle involved in the pouring of castings by this method is to run them from their thinnest section, so that the metal will freeze almost simultaneously throughout the mass of the casting, and to run the metal at such a rate that freezing will take place within as short a time as possible after the completion of the pour, thus reducing to the practical minimum the amount of liquid contraction in the period after the mold has been poured. By these means a casting can be poured with a runner or runners of relatively extremely small area, the total weight of the metal not employed in the actual casting being reduced to an almost insignificant amount compared with the weight of the casting. With the rate of pouring thus controlled, the metal first poured, as it cools and contracts, is said to feed itself from the metal poured afterward while pouring is still in progress.

It is claimed that with this method of casting not only a greater part of the melting scrap is eliminated but also sounder castings and a smaller proportion of wasters is produced. (*The Metal Industry* (London), vol. 20, no. 18, May 5, 1922, p. 417, *dp*)

Another instance of casting without a riser is described from American practice, with reference to the experience of the author in 1916 in connection with casting copper bands in sand. After some trouble a successful attempt was made to cast large copper bands weighing 30 lb. with a gate weighing only 1.75 lb. without using either risers or chills. The bands cast by this system are said to be clean and solid. To do this the copper was poled till brought to a good tough pitch. It was then poured at about 2500 deg. fahr. and just hot enough so that the head would not swell. At another time

similar castings were made by the author of 98 per cent copper and 2 per cent nickel mixture in sand without risers or chills. (Casting Copper Without a Riser, by Nelson F. Flanagan, *The Metal Industry* (New York), vol. 20, no. 5, May 1922, p. 182, 1 fig., *dp*)

HYDRAULICS (See Pumps)

INTERNAL-COMBUSTION ENGINEERING

Schuele's Tests of a Holzwarth Gas Turbine

Thyssen-Holzwarth Oil and Gas Turbines, Prof. W. Schuele. Tests made by Professor Schuele with the Holzwarth gas and oil turbine have led him to the conclusion that so far only that turbine satisfies the conditions imposed by the operating functions and work in modern plants. It is claimed that a thermodynamic efficiency of 45 per cent is attained with the Holzwarth process at a compression ratio of three as against a ratio of twelve in the piston gas engine. It is really the efficiency of compression that goes far to determine the comparative overall efficiencies of the gas turbine and reciprocating engine.

Another important consideration is the temperature condition in the unit. In the Holzwarth turbine the time during which the high temperatures prevail is short and is followed by a period of low temperature, which makes the Holzwarth explosion turbine as safe as a piston engine. It is said that the combustion turbine cannot operate without this rhythmical change of temperatures.

As compared with the steam turbine the gas turbine is remarkable from the fact that it requires but one stage for its drop of pressure from 230 lb. to atmospheric pressure, a ratio of sixteen. In the steam turbine the jet works uniformly, while in explosion turbines it works like a shot with decreasing jet velocity. Fortunately, this does not matter much, as is shown by Figs. 1 and 2. In Fig. 1 *BHC* represents the *p-v* diagram of the Holzwarth turbine working with a compression pressure of 2.2 atmos. and an explosion pressure of 17.3 atmos. abs. While the pressure decreases during the expansion from 17.3 atmos. abs. to 7.3 atmos. abs., the part

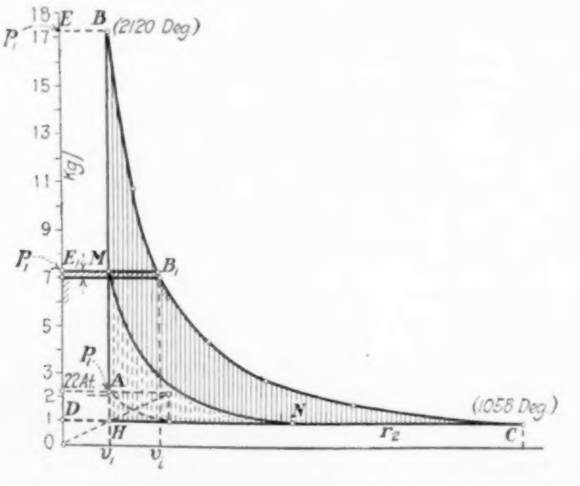

Fig. 1 Pressure-Volume Diagram of the Holzwarth Explosion Turbine

of the energy marked with vertical lines has been transformed into kinetic energy and only the small balance below *MN* is left.

Fig. 2 shows that the jet velocity decreases slowly until about 90 per cent of the total energy is transformed into kinetic energy. During transformation of the last 10 per cent, however, which is not of much importance, the jet velocity decreases at a more rapid rate, and the efficiency of the one-stage turbine is therefore not much lower than that of a similar steam-turbine wheel. The shocks which the wheel blades have to stand in the Holzwarth turbine are, of course, much greater than with steam turbines.

Schuele made tests with a vertical 1000-hp. experimental gas turbine and found an efficiency of 25 per cent with the engine developing 1200 hp.

In this connection attention may be called to an article entitled Thermodynamic Bases for Determining Efficiency to be Expected from Gas Turbines, by H. Schmolke, abstracted from a German publication in Mechanical Engineering, March, 1922, pp. 187–190. This article is also largely based on the experience with the Holzwarth turbine and tests of Prof. Schuele. (Chapter from a German book translated by Hans Holzwarth, the inventor of the turbine, and published in *Motorship*, vol. 7, no. 5, May, 1922, pp. 351–53, 9 figs., *d*)

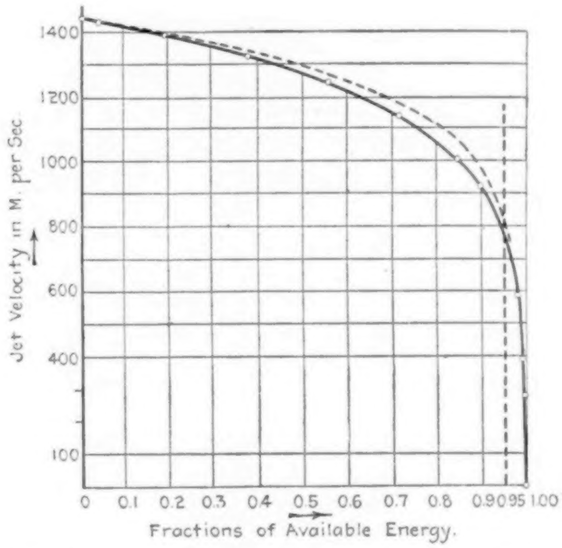

Fig. 2 Variation of Jet Velocity in the Holzwarth Explosion Turbine

MACHINE DESIGN AND PARTS (See Power Transmission)

MACHINE TOOLS

Abbreviations for Machine Designers

Methods of Machine-Tool Design, A. L. De Leeuw, Mem. Am.Soc.M.E. Among the things discussed in this article are a set of symbols (Fig. 4) which the author used as a sort of designer's shorthand. They are merely simplified, one might say skeletonized, indications of various machine parts and might be useful for

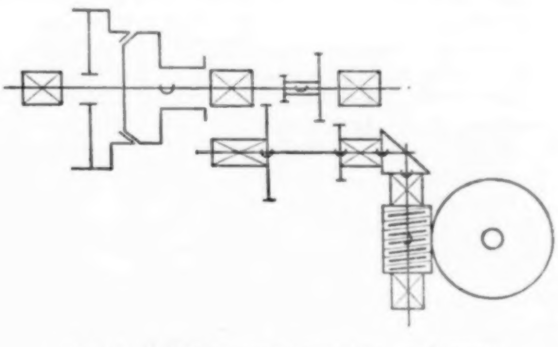

Fig. 3 A Mechanism Indicated by Symbols

preliminary sketches. Fig. 3 shows an arrangement of a gear mechanism represented by means of these symbols. There is a pulley with friction clutch, the clutch being keyed to a shaft. To this same shaft is keyed a pair of sliding gears which can mesh with two stationary gears on another shaft, and to this second shaft is keyed a bevel gear driving another bevel gear on a third shaft on which is keyed a worm driving a worm wheel. (*American Machinist*, vol. 56, no. 17, Apr. 27, 1922, pp. 617–620, 3 figs., *p*)

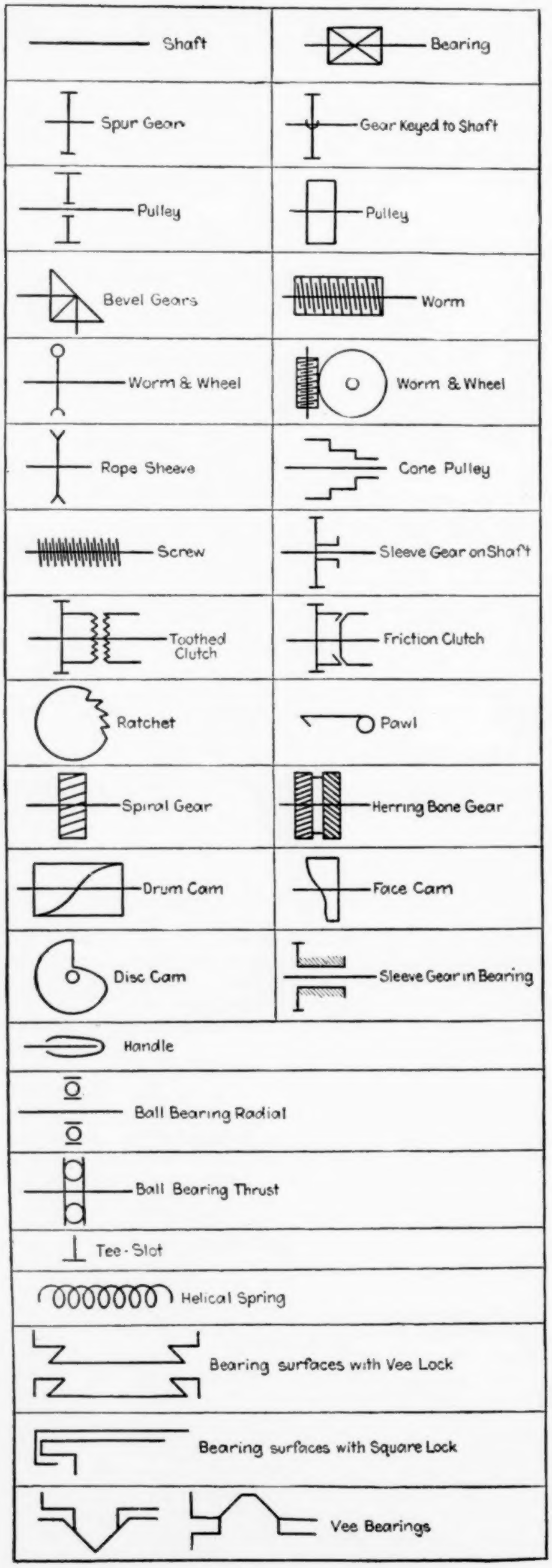

FIG. 4 DESIGNER'S SHORTHAND SYMBOLS

MARINE ENGINEERING

VOYAGE AROUND THE WORLD OF MOTORSHIP "WILLIAM PENN." On March 19 the *William Penn* completed her maiden voyage around the world of 28,500 miles. She is the first large American motorship suitable for deep-sea cargo trade. On her return to New York the propelling machinery was found to be in perfect condition, requiring no repairs. The exhaust and inlet valves of the main engines were changed only once, which was at the middle of the voyage. All work on the main engines was done by the engineer personnel when in port and all similar work on the auxiliary engines and machinery was done while under way at sea. There was no involuntary stopping of the vessel at any time throughout the voyage.

The two main engines are six-cylinder, $29^1/_8$ in. by $45^1/_4$ in. They were originally designed to run at 115 r.p.m. and deliver together 4500 i.hp., but because of the full form of the *William Penn* the power was cut down by reducing the revolutions to 108, corresponding to an output of 4200 i.hp. and a speed of 11.5 knots. In addition there are three auxiliary Diesel engines each direct-coupled to a 65-kw. generator for supplying current to the various electrically driven engine-room and deck machinery. At sea only one of the auxiliary engines was required and carried a load of about 55 kw.

The mean sea speed from New York to London was 11.01 knots with a mean fuel consumption of 13.06 tons per day (exclusive of donkey boiler). The longest non-stop run was from Singapore to Suez, 4943 nautical miles, taking nearly 18 days with a mean sea speed of 11.48 knots and mean total consumption of main and auxiliary engines of 13.41 tons per day, equivalent to a consumption per indicated horsepower of 0.3025 lb.

The original article gives a comparison between the *William Penn* and the electrically driven ship *Eclipse*, which, while not entirely strict, appears to be in favor of the motorship. It is also pointed out that there are several sister ships of the *William Penn* equipped with either steam turbines or reciprocating engines which have been laid up for the past year or more due to their inability to operate at a profit, while the *William Penn* sailed in April for the Far East again, carrying chiefly heavy or dead-weight cargo consisting mostly of structural steel and loaded down to the full-draft marks. With this class of cargo she is able to carry about 1000 tons more than an equivalent steamer, this amount representing the additional fuel and fresh water which the steamer has to carry.

On the way out the vessel encountered severe storms, and it became necessary to slow down to prevent losing the deck cargo. On the return trip the vessel was not fully loaded, although the cargo was of a bulky nature, consisting of hemp, copra, rattans, tapioca, coffee, etc. (*Marine Engineering and Shipping Age*, vol. 27, no. 5, May, 1922, pp. 313–314, 1 fig., *dc*)

MEASURING INSTRUMENTS

THE ROTAMETER. Description of a new device for measuring the rate of flow of any gas or liquid through a pipe per unit of time. This device, the rotameter, consists essentially of a vertical transparent tube with a bore tapering toward the lower end and within which there is a circular, top-shaped float. The stream of gas or liquid flowing through the tube lifts this float and the quantity passing through is directly read from an accurately calibrated scale fixed to or engraved on the tube. The accuracy of the apparatus lies in the peculiar construction of the float which is kept in rapid rotation by the steam of gas or liquid flowing past it. The float does not touch the walls of the tube and the instrument is assumed to be frictionless. The rotational movement of the float is much more sensitive to disturbance than the vertical movement and there is a continuous check upon the accuracy and proper functioning of the instrument. After long use the float and tube may become fouled and when a certain degree of fouling is reached the float will cease to rotate, thus giving warning that the instrument requires cleaning. It is stated, however, that the rotation ceases long before the accuracy of the vertical motion of the float, and consequently of the readings, is appreciably affected. (*Iron and Coal Trades Review*, vol. 104, no. 2826, Apr. 28, 1922, p. 612, 1 fig., *d*)

POWER-PLANT ENGINEERING (See also Railroad Engineering)

British Steam-Turbine Drive for Textile Mills

A Steam-Turbine Mechanical Drive for Textile Mills. Description of a unit designed by the Metropolitan-Vickers Electrical Co., Ltd., Manchester, England. The intention is to employ machines in sizes varying from about 800 to 2000 b.hp., which is a range that should cover the requirements of textile mills. The condenser is located immediately below the turbine exhaust, but the height from basement to ceiling is only 15 ft.

As regards efficiencies, it is stated that for a turbine of 1500 hp. the makers are prepared to guarantee that the steam consumption will not exceed 10 lb. per b.hp-hr. with steam at 180 lb. pressure, superheated 180 deg. fahr. and a vacuum of 28.5 in. This is equivalent to, say, 9 lb. per i.hp-hr. for a steam engine.

The condenser pumps are to be driven by ropes from the main turbine and a small steam engine is provided for driving them until the turbine is up to speed, after which the engine is cut out by means of a clutch. Where electricity is available for starting purposes, a small motor could be used instead of the steam engine.

Where there is a demand for steam at a pressure of 20 or 30 lb. for heating, drying, boiling, etc., the use of a turbine is economical as it takes very little more heat to raise steam to a pressure of 180 lb. than it does to raise low-pressure steam to 30 or even 60 lb. for heating. On the other hand, steam in expanding from 180 lb. to, say, 30 lb. can be made to do a great deal of useful work in passing through the turbine.

Where the whole of the exhaust from the turbine can be utilized irrespective of the load on the generator, a back-pressure turbine is usually installed; but the instances in which this type of turbine can be employed are limited, since it generally happens that the demand for heating steam is irregular and does not coincide with the demand for power. In other words, whereas with a back-pressure turbine there is a direct connection between the amount of steam available for heating purposes and the work which can be done by the turbine, there are other and more numerous schemes of power plant in regard to which the amount of power required and the demand for heating steam bear no relation to each other. A turbine is therefore required which will give either heating steam or electric power independently, and as the demand for either varies. These requirements are met by the reducing-pressure turbine, which consists of a back-pressure turbine and a low-pressure turbine arranged within one casing and having one shaft. The chief merit of this combination is that it possesses the advantages of an ordinary high-pressure turbine, in that low-pressure stages are provided, through which all surplus steam which has not been discharged into the heating mains can be economically expanded to condenser pressure.

It is of the utmost importance from the point of view of economy that the heating-steam pressure to be maintained by the turbine should be reduced to the minimum pressure which will suffice for the particular heating process under consideration. In the great majority of heating schemes the important point to bear in mind is that the energy dissipated in the process of heating is derived from the latent heat of the steam and not from the sensible heat. When this principle is grasped it will be seen that the back pressure against which the turbine is required to work should be as little as possible above the pressure which corresponds to the temperature required at the point where heating takes place. The loss of energy—and, therefore, of fuel—which results from raising the pressure in the heating mains above the necessary minimum is out of all proportion to any small increase obtained in the heating capacity of the steam.

The article compares the steam turbine and the reciprocating steam engine from several viewpoints, such as steam consumption, mechanical losses, radiation losses, etc., the comparison being on the whole in favor of the steam turbine.

A typical Metropolitan-Vickers reducing-pressure turbine is shown in diagrammatic form in the original article. In this illustration the steam chest and valve gear are shown attached to the top half of the cylinder. This is merely for the sake of facilitating an inspection of their functions. (*Mechanical World*, vol. 71, no. 1843, Apr. 28, 1922, pp. 307–309, 4 figs., *dc*)

POWER TRANSMISSION

Causes of Vibration and Chattering in Geared Drives

Nodal Arrangement of Geared Drives, Dr. J. H. Smith. In power-transmission systems consisting of shafts and toothed wheels it was often found that the gearing chattered. With the introduction of gear wheels running at high speeds the chattering conditions became very pronounced in certain cases. In certain motor cars there are ranges of speed in which it is impossible to secure quiet running without the aid of special appliances; in electric tram-car systems the phenomenon of rail corrugation appears and leads to serious trouble, but the most serious trouble is met with in the geared drives of turbine-propelled ships. The difference in the three cases apparently arises from the difference in size of the rotating masses employed.

Conditions are often particularly bad in double-reduction-gear systems. Occasionally a double-geared ship is produced which appears to give complete satisfaction, while occasionally a roarer is turned out which is found to be unsatisfactory even at half speed.

Various methods have been suggested for the reduction or elimination of chattering and its concomitant phenomena, such as increase in the amount of oil; reduction in pitch of teeth; shortening or lengthening of teeth; increase in the width of the teeth; and finally, adding flywheels and elastic couplings at various points of the drive. The author attempted to carry out a more or less complete mathematical investigation of the causes that led to the chattering. It is believed that the results of this investigation will point out the only possible solution of the problem.

The mathematical part of the paper is not suitable for abstracting and only some of the conclusions arrived at can be reported here.

In the first place, the author established the fact that there is a certain critical speed and defines it as a speed of revolution such that the amplitude of the fluctuating tooth-pressure torque is equal to the transmitted torque. At this speed parting of the teeth will occur. As the speed of the drive is gradually increased, the external periodic action will gradually search out the critical speeds of the system, and if any continuous running is allowed at any one of these synchronizing conditions, dangerous oscillations and chattering may occur. If the equation defining these conditions has (as it may have) a large number of roots lying within the range of the speeds of revolution of the various shafts, there will be a large number of critical speeds.

From a further investigation of the subject the author arrives at the conclusion that the effect of adding either a single mass or an elastic connection to a simple system of gears will increase the number of degrees of freedom of the system, and hence increase greatly the number of critical speeds.

In investigating the effect of tooth-form irregularities it is found that the searching periodic irregularities may be looked upon as a series of fundamentals for frequencies equal to the speeds of various shafts corresponding to inaccuracy in the centering of the wheels, together with a series of harmonics which it would be rather difficult to define, but which, in the upper limit, have periodicities corresponding to the number of contacts per minute. The author states that he knows of the case of a periodic variation in the thickness of the teeth every twelve teeth in a newly cut primary wheel. Periodic variations of tooth thickness are often observed in the worn gear wheels of motor cars.

It does not seem feasible at present to determine analytically the critical speeds arising from irregularities of teeth, as we have no information on the values of these periodic irregularities. If the degree of accuracy of gear cutting were known, the problem could be solved in the same way as that employed by the author for the effect of periodic torques. As this cannot be done, he attempts to solve it in a different way, and comes to the following statement of conditions best adapted for avoidance of the critical speeds which may arise from high-periodicity irregularities of the teeth of gear wheels in elastic-shaft geared drives.

The shafts must be made as flexible as possible and the ratio of the moment of inertia of the mass attached to any shaft to its attendant wheel must be as large as possible.

In the case of the low-periodicity irregularities arising from

varieties of pitch, inaccuracy of centering, etc., the only possible means of avoiding critical speeds may be stated as follows:

The system adopted must be such that it possesses the least number of possible free vibrations and the periodicity of these free vibrations must be as low as possible so as to be outside the range of all disturbances.

In order to simplify a proposed elastic-shaft geared drive, with the object of securing an arrangement which shall have the least number of possible critical speeds, and therefore the least chance of coincidence of any of these with any impressed periodic actions arising either from the action of unknown internal irregularity or known and unknown external periodic disturbances, a certain amount of ingenuity is required. No common line of procedure can be chosen which will be suitable for the most general arrangement. When designing a drive one may have to study the peculiarities of the known disturbing elements, and in some cases it may be necessary to split these elements into their component parts. In all such cases the component parts will consist of a fundamental and a series of harmonics having periodicities that are simple multiples of the periodicities of the main feature of the disturbance. Such considerations will lead to the formation of a family of periodicities. An arrangement of the drive will then have to be made of such a nature that the possible critical speeds are so placed that synchronism does not occur between any one of them and any member of the family of the impressed periodicities. General considerations on a question such as this are of course always difficult to deal with, but after carefully considering the possible variations of the numerous elements with which we are concerned in elastic-shaft geared drives, the author is led to the opinion that the required reductions are best secured by: (1) Simplifying the system; (2) tuning the system; (3) making the elasticities and masses of certain shafts dynamically similar; (4) adjusting the phases of the disturbance; (5) attempting the elimination of high periodicity disturbances by lowering the pitch of the possible free vibrations of the system; (6) arranging the periodicities of the disturbance in a definite and simple family; and (7) reducing the moments of inertia of the wheels of the attendant train to the least possible value.

The difference in behavior of single-reduction and double-reduction systems would appear to be partly explained as arising from the simple nature of the former. In a single-reduction arrangement there are only one-half the number of tooth connections, and hence, roughly speaking, only one-half the number of possible critical speeds and smaller critical-speed ranges than in the corresponding double-reduction arrangement. With the present haphazard method of designing them, the single-reduction arrangement has a far better chance of success than the corresponding double-reduction type. It should not be necessary to dwell on this aspect of the question; the mathematics given in the paper should make it quite clear, for example, that any arrangement having two or more masses attached at different points to any shaft must either be cut out, or precautions must be taken to bind the masses together so that they behave practically as one solid mass. The suggested use of a flywheel on the propeller shaft is without doubt a mistake; it would increase the degrees of freedom of the system and hence the number of possible critical speeds. Any change in the moments of inertia of the propeller or of the shaft dimensions would not increase the number of possible critical speeds, and is therefore not objectionable. It may be observed also that all elastic shafts in the gear box must be cut out; that is, the driver and drive wheels mounted on any shaft must be bound as rigidly together as possible. In short, our systems must be reduced to a one-mass shaft system, and if this is done we have simplified the system in a general way as far as it is possible.

It is often possible to make a group of shafts, together with their attached masses and transmitted torques, dynamically similar, and in such cases the behavior of all the shafts in the group becomes identical and they can be treated as one individual shaft. In this way the number of tooth connections is reduced from the number appearing in the group of shafts to the number appearing in one shaft, and hence the critical ranges will be the same for all members of the group. The simplest conditions to be satisfied in such a reduction are first that the shafts of the group are tuned to the same free periodicity; second, that the masses mounted on the shafts are identical; and third, that the torques transmitted by the shafts are the same. The simplification dealt with here will be of importance when the external disturbing periodic couples can be reduced to one couple action on one shaft.

In certain cases the phase of the disturbing periodic couples will be known with a fair degree of accuracy, and hence by an adjustment of various shafts it will be possible to arrange that these couples cancel each other when taken in pairs. In such arrangements the shafts considered will have to be tuned to the same periodicity and assembled in an appropriate manner. As an example of this, it might be stated that the simplest nodal arrangement which could be devised, if the elimination of the fluctuating torque arising from propeller-blade disturbance is the important consideration, would consist of twin propeller shafts connected to one gear box and suitably assembled.

The author suspects that in many cases angular oscillations have been occurring in turbine rotors, and have been so pronounced as to give rise to appreciable fluctuating couples. If such periodic torques are possible it would appear that they can only be tuning down the possible free vibrations of the system in question to the lowest pitch.

As a general conclusion on simplification the author states that the tuning or nodalizing of any gear drive is the most direct and important dynamical means of attacking the problem when it is proposed to reduce the number and magnitude of the possible critical-speed ranges.

In order to illustrate the use of the equations and conclusions deduced analytically, the author deals in a broad way with two simple problems in which the arrangement of gears and elastic shafts consists of two prime-mover shafts geared to one propeller shaft, which is the common form of arrangement used in ship propulsion. He also gives what he calls a critical-speed diagram. This part, though interesting, cannot be abstracted owing to the lack of space. (Paper before The Institution of Naval Architects (British), read April 6, 1922, and abstracted through *Engineering*, vol. 113, nos. 2936 and 2937, Apr. 7 and 14, 1922, pp. 438–440 and 467–469, 1 fig., *tmA*)

PUMPS

Pipe Friction and Pump Efficiency. Discussion of a paper by W. Brazenall read previously before the Mining Institute of Scotland. The speakers point out the great losses of money in collieries through the use of inefficient pumping installations. (*The Iron and Coal Trades Review*, vol. 104, no. 2826, Apr. 28, 1922, p. 611, *p*)

New Vacuum Pump, H. Vigneron. While the new pump is built on the same basic principle as the Gaede vacuum pump, using an eccentric rotation of a heavy cylinder in a hollow cylindrical chamber, it is capable of producing a vacuum equal to 0.0001 mm. of mercury and of doing this in one unit, i.e., without the intervention of an auxiliary pump.

The original article describes and illustrates the details of this pump. In tests made in exhausting a container having a volume of 13 liters (3.43 gal.) the pump running at 225 r.p.m. produced the following vacuums: at the end of 30 min. a pressure of 0.00786 mm. of mercury; at the end of one hour 0.00119 mm., and at the end of two hours 0.00092 mm. of mercury. (*La Nature*, no. 2504, Apr. 1, 1922, pp. 197–199, 3 figs., *d*)

RAILROAD ENGINEERING

Superheater Flue-Hole Liners. The author advocates copper liners in the firebox tubeplates of superheater boilers as a means of combating the difficulties arising from deterioration of tube holes and the constant leakage produced thereby. He describes in some details the manufacture of liners and their fitting into the tubeplate as well as the tools used.

As an example of the value of these liners is cited the case of a heavy passenger engine used on the main line between London and Carlisle with superheater tube holes of the firebox tubeplate 4 3/8 in. in diameter. There was, however, constant trouble with leaky tubes, necessitating frequent rolling and rerolling which resulted in rapid deterioration of the plate, so that in February, 1915, after one year

and ten months' service, it became necessary to fit a new firebox tubeplate. This new plate lasted for a year and eight months and the engine had to be returned to the shops for repairs in December, 1916. By this date smoke-tube-hole liners had been introduced and eleven of them were fitted in the tubeplate of the boiler. After a run of approximately 71,000 miles the engine was again in for repairs in December, 1917, that is, after two years and eight months' time, and the condition of the tubeplate was such that it was decided to take these eleven liners out and equip the plate with a full set of twenty-four. The new plate remained in service until September, 1919; that is, the liner-equipped plate had a life $2^1/_2$ times that of the former plate not so equipped. These liners have also done good service in engines fitted with steel fireboxes and have been successfully applied to the repair of cracked tubeplates. (*The Railway Engineer*, vol. 43, no. 507, April, 1922, pp. 134–135, 12 figs., *d*)

Locomotive Types from a Transportation Viewpoint, J. F. Porterfield. The items going to make up the cost of freight-train operation, except crew wages, do not materially decrease with the increase of locomotive capacity. From various estimates the increased cost of maintaining the large 2–10–2 type compared with the cost of the 2–8–2 or Mikado type, works out at about 20 per cent with a decrease of about 10 per cent in mileage, these items with the increased cost of ownership being about equal to the saving in crew wages.

There is a useful field for the large locomotive where grades exceed 0.5 per cent, and particularly where the preponderance of traffic is in the heavier commodities not requiring preferential movement. On train districts with easier grades where the traffic is fairly well divided between the heavier and lighter commodities the Mikado-type locomotive is the proper type to use. The Mikado type is also better adopted to movement of high-class freight. All of these statements are supported by the author by various calculations.

On the whole, he comes to the conclusion that because of the increased cost of maintenance and of ownership and the decrease in efficiency of the extremely large types of locomotives, careful study and consideration should be given to the grade and traffic conditions, the train frequency or road capacity, the terminal expense required to reduce or increase trains, and other operating conditions before making an investment in locomotives of the larger types. Consideration should also be given to increasing the hauling capacity and productive time or mileage of the existing types, as well as reducing the fuel cost of their operation. (Paper before the Western Railway Club, Apr. 17, 1922, abstracted through *Railway Review*, vol. 70, no. 16, Apr. 22, 1922, pp. 565–566, 1 fig., *pc*)

Flexible-Pipe Feedwater Connections Between Engine and Tender. The connections were made on consolidation-type locomotives on the Bangor and Aroostook. At first there was a single large pipe line on the center line of the locomotive through which both injectors were fed, but this type of connection met with the objection that a failure of the pipe would entirely cut off the feedwater supply and cause a complete engine failure. Because of this the arrangement was changed so as to provide a separate connection for each injector.

At the tender end the connections are attached to plates riveted to the bottom of the tank, and the upper joints are each connected by a short nipple to one of the tank wells. This arrangement with the connections apply directly to the tank instead of to the tender frame is intended to eliminate the possibility of leakage, resulting from slight shifting of the tank.

Connections of this type with feed lines 2 in. in diameter have been in service for several months during the past winter, during which time the locomotives have averaged about 30,000 miles with no maintenance required to the feedwater line. The severe climatic conditions prevailing during the winter months on this line require almost constant use of the heaters when the injectors are not working, and it is estimated that the same service would have required at least one and probably two renewals of the ordinary hose connections. (*Railway Age*, vol. 72, no. 18, May 6, 1922, p. 1070, 1 fig., *d*)

Springs and Draft-Gear Design Data for Freight Cars

Springs, Draft Gears and Other Problems in Car Design, Prof. Louis E. Endsley. In the design of a freight car there are two distinct problems to be taken into consideration. One is the direct vertical load, and the other is the shock or pressure produced between two cars whenever they come together at varying speeds.

None of the parts above the springs should receive shocks from a direct vertical load, and by shocks is meant here that force which is produced by the springs going solid.

The author believes that springs should be designed with a greater capacity than is now done is some instances, and the capacity of springs should not be less than 200 per cent of the normal weight of the car and lading, with the car standing still, and 250 per cent would probably be even better.

In tests made by the author on the Pennsylvania Railroad in 1914, he found that with 200 per cent spring capacity in trips of the experimental car between Pittsburgh and Alliance many solid impact blows were delivered between the bolster and the side frame. Another set of springs which were 300 per cent of the normal load never went solid and there was only one impact recorded that was over 225 per cent of the normal load.

The use of springs of greater capacity would not only protect the car better but would also reduce materially the breakage of springs. The parts of the car which are below the springs, namely, the side frames, need extra weight in them. In tests which the author made to determine the effect of the impact blow upon the side frame after the springs went solid, he found that it takes only a little more energy than that necessary to close the springs to cause some very excessive forces.

Draft-gear problems with modern solid steel cars are not considered to have been entirely solved. They would have been, however, if a draft gear had been used in each car that would never go solid without a pressure above the coupler and still strength but this is not a fact, as we have never yet been able to keep our switching speeds below the impact point.

The old wooden underframe for freight cars was in a better condition to withstand stresses than the modern steel underframe, because it gave two inches as compared with the give of one inch for the steel frame. On the other hand, however, railroads are now willing to permit an increase in draft-gear travel.

Steps should be taken to keep the draft-gear capacity up so that we can keep in the service longer the old and medium-weight cars. If our old cars have an impact capacity of only 600,000 or 700,000 lb., and we design cars with a new underframe that has a capacity of over 1,000,000 lb. and these cars come in contact, without an adequate draft gear in each of them, there is not much doubt which one of the cars is going out of commission. As long as we keep together two cars of equal strength they will stand a great many impact blows in the switching after the draft gear goes solid, but when they come into contact with cars of greater capacity the old cars will go out of commission very fast; while if we should design the new cars with a draft gear and arrangement that would take care of a reasonable switching speed, we would keep in service many cars which are now going out of service. Today we have draft gears which will take care of switching speeds between $3^1/_2$ and 5 miles an hour when new, but unless they are kept under repairs, the speed at which they will protect the car will be reduced considerably. (Abstract of an address before the recent meeting of the Virginia Section of The American Society of Mechanical Engineers. *Railway Review*, vol. 70, no. 17, Apr. 29, 1922, pp. 591–594.)

ROLLING MILLS

Power Required to Roll Wrought-Iron Bars, Edwin L. Fletcher. Results of tests in reducing 3-in. billets to $^1/_2$-in. round, of particular interest because of the comparative scarcity of published information on rolling wrought iron, where the conditions are somewhat different from those obtaining in the rolling of steel.

The heat loss between the roughing mill and the merchant mill is much more serious in rolling wrought iron than in rolling steel,

and proper timing at this point may easily cut the scrap loss in half.

Under modern conditions the spacing between roughing and merchant mills may be as high as 32 ft. centers and the billets weigh from 100 to 135 lb. The original article gives data as to power consumed over a number of days of rolling of the product of eight puddling furnaces for wrought-iron bars to meet the requirements of railroad shops and chain makers. (*The Iron Age*, vol. 109, no. 17, Apr. 27, 1922, p. 1144, *e*)

SHIPBUILDING (See Power Transmission)

SPECIAL PROCESSES

Anderson Process for the Hot Rolling of Gears

The Hot Rolling of Gears, Reginald Trautschold. Description of a process devised more than ten years ago by H. N. Anderson, Mem. Am.Soc.M.E., and now practiced by the Anderson Rolled Gear Company.

In previous attempts at hot rolling of gears only one of the operating shafts of the rolling apparatus was positively driven, which produced a slip between the die roll and the blank, with the resulting distortion of the teeth of the molded gear and lack of accuracy in tooth spacing.

Mr. Anderson conceived the idea of positively driving both shafts and accurately synchronizing their rotation by means of suitable timing gears, and it was found that the gears were such that no finishing of the teeth was necessary. He was awarded for this development the John Scott Legacy Medal by the Franklin Institute in 1915.

In the actual process of rolling gears the blank heated to a temperature of from 2000 to 2100 deg. fahr. is mounted on the work arbor of the rolling machine and securely clamped in place by means of a powerful auto-manipulator. The arbors carrying the die roll and the heated blank are actuated by suitable heavy timing gears and the die and blank are rolled together in synchronized contact under a rolling pressure of from 10 to 20 tons. At the start of the rolling the die is clear of the blank, but advances gradually until the teeth of the die have penetrated the blank their full depth. As the rolling is done as a rule at speeds varying from 400 to 700 r.p.m., the advance of the die roll per revolution is very slight. This insures a thorough kneading and working down of the metal of the blank and permits easy flow of the metal as it is displaced and built up by the die.

During the rolling operation the die is cooled by a stream of water directed against its face at a point opposite to that in contact with the blank. As the entire rolling consumes less than 15 sec., this cooling prevents the temperature of the die from rising above that easily bearable by the hand. The chilling effect of the cold, wet die roll on the hot blank causes a rapid contraction of the latter and loosening of the forging scale as it is formed. The loosened scale is then thrown free by the centrifugal force due to the high speed of rotation of the blank. Because of this in the finished gear the teeth are not only perfect in shape but are highly polished on all contact surfaces.

In order to attain the highest degree of precision in the form of the teeth molded, machines designed for the production of the most accurate gears are equipped with additional mechanism for frequently and automatically reversing the rotation of the die and blank. This frequent reversing or oscillation, at somewhat reduced speeds, varying from 80 to 200 r.p.m., is maintained during the forming of the molded teeth and until the die is within 0.01 in. of full penetration. The action then automatically reverts to high-speed direct rolling for the planishing effect. The oscillating methods tend to effect displacement and building up to a somewhat more equal and constant degree on both sides of the teeth than if rolling in one direction is maintained, thereby producing a more perfectly symmetrical tooth form.

Herringbone gears may be produced as accurately and cheaply as the other types by using a compound die roll. For the production of all types of bevel gearing the crown-gear form of tooth is used and in many cases the crown-gear type of die roll. If, however, the gear to be rolled is to be of a given number of teeth of a certain pitch, such as the standard pitches now in general use, its diameter is also definitely fixed. As the diameter of a crown-type die roll is established by the length of the conical element of the gear to be rolled, it is apparent that the circumference of the crown-gear die roll may not be commensurably proportional to that of the blank. The crown-gear die roll would not, therefore, accommodate a full number of teeth of the given pitch, but this may be overcome by the use of a flat bevel die roll, shortening the diameter of the die until it is commensurably proportional to that of the gear blank.

All die-roll faces are somewhat narrower than those of the gear blanks, thus producing gears partly or wholly shrouded. Consequently, if it is desired to strengthen the weaker member of a pair of gears, the shroud may be left on, either entirely or partly, or the shrouds on the two gears may be so proportioned as to equalize the strength of the two and greatly increase that of the combination. The increase in strength cannot well be definitely established, but considering also the greater inherent strength of rolled teeth, it is probably a conservative assumption that shrouded gears can be proportioned and rolled which possess double the strength of ordinary cut gears of the same pitch.

The greater inherent strength of rolled gears is due to the effect on the structure of the metal of rolling at high temperature and under high pressure. This pressure and the thorough kneading action of the die teeth while the metal is in a plastic state, in addition to building up and compressing the metal into the formed teeth, gradually breaks up the normal coarser crystalline structure and produces a dense, thoroughly worked metal of almost fibrous characteristics. The minute crystals are rearranged in a truss formation following the periphery of the finished gear, thus tying the teeth to the body of the gear and equalizing the structural strains. In fact, the reduction of internal structural strains is so marked that no distortion whatever occurs in subsequent heat treatment of the gears and it has even been found unnecessary to use any clamps for the purpose of holding the gear true when quenching.

The modified metal structure also materially increases the hareness and wearing qualities of the gear teeth and assures a mord uniform result from case-hardening or other heat treatment. Exacting laboratory tests, confirmed by service tests under the most severe operating conditions, have shown an average superiority for rolled gears of 25 per cent in strength and 20 per cent in hardness, as shown in the tables.

	Machine-cut gears	Hot-rolled gears
Normal Condition:		
Yield point	6470 lb.	7918 lb.
Ultimate strength	12250 lb.	13645 lb.
Hardness	22	26
Case-Hardened:		
Yield point	13529 lb.	14750 lb.
Ultimate strength	17250 lb.	19130 lb.
Hardness	87	85
Depth of case	0.027 in.	0.035 in.

It is stated that the gear-rolling method is more economical than the usual machining process.

The problem of ultimate perfection of the process thus became primarily one of developing a system of die rolls which would form perfect and efficient gears with a high degree of accuracy at low cost and which could be redressed when necessary without affecting the precision of form of the molded teeth. The perfection of such a system of dies and their adaptation to use on a practical and efficient machine operating on the principle evolved have now made feasible the commercial production of gears by a true molding process. (*Blast Furnace and Steel Plant*, vol. 10, no. 5, pp. 270–273, 2 figs., *dA*)

TEXTILE MILLS (See Power-Plant Engineering)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Coal. The Ignition Temperature of Coal. See *Fuels, Gas, Tar and Coke A9-22.*

Electrolysis A1-22. Electrodeposition of Iron. In view of the extended use of electrodeposition of iron for many industrial purposes the Department of Scientific and Industrial Research, Westminster, London, S. W. 1, has considered it advisable to issue the present bulletin which embodies the results of research carried out by W. E. Hughes, with the assistance of grants made by the Department.

The contents of the report are arranged under the following headings:

Division 1: Descriptive. (*a*) General note on the description of the deposits; (*b*) Series I, on the effect of temperature; (*c*) Series II, on the effect of current density; (*d*) Series III, on the effect of mechanical movement.

Division 2: Theoretical. (*a*) The crystallization of substances in general; (*b*) application to electrodeposited metal; a consideration of the results of the experiments of the Series I, II, and III. Some remarks on deposits (1) from other iron solutions; (2) of other metals. General conclusions; (*c*) workshop application.

Appendix. Bibliography comprising references to publications on: (*a*) the electrodeposition of iron and phenomena connected therewith; (*b*), the properties of electroltyic iron; (*c*), works of reference relating to the electrodeposition of iron.

The bibliography will be of use to those desiring general information upon the subject, as well as to research workers. The report is copiously illustrated by microphotographs. Copies of the report may be obtained by addressing His Majesty's Stationery Office for the Department of Scientific and Industrial Research, Imperial House, Kingsway, London, W. C. 2. Price per copy 6s. 6d. (By mail, 6s. $8^1/_2$ d.)

Expansion A1-22. Thermal Expansion of a Few Steels. Scientific Paper No. 433 of the Bureau of Standards on this subject was prepared by Wilmer Souder and Peter Hidnert. Thermal-expansion data on 28 samples of iron and steel are given. One sample of vacuum electrolytic iron and one of gray cast iron are included. A specimen of hardened steel has been tested to show the dimensional changes incident to heat treatment or drawing. Twenty-two curves and a 2-page table are used to summarize the results.

The average expansion of the specimen of electrolytic iron is 12.0×10^{-6} for the range 25 to 100 deg. cent.

For 25 steels:

11.2×10^{-6} for the range 25 to 100 deg. cent.

14.2×10^{-6} for the range 25 to 600 deg. cent.

Above the critical region the values usually jump to approximately 23×10^{-6}.

The values on cooling are not very different from those on heating; the transformation regions are displaced as usual.

The contraction and expansion reversals within the critical regions vary from a few microns per meter, if any at all, for a 3.7 per cent silicon steel, to almost 2000 microns per meter for a 1.2 per cent chrome steel (C. 0.35; Cr., 1.17; V. 0.14).

The critical region was found to extend over a temperature interval of from less than 6 deg. cent. for electrolytic iron to something over 100 deg. cent. for a special 1.1 per cent manganese steel. These differences in dimensional changes and extent of critical region are suggested as a means for determining the tendency toward cracking or warping when parts of specimens are quenched at unequal rates. This rate is always different, depending upon the size, shape, etc. The specimen of cast iron showed irregularities and considerable permanent growth upon heating, the growth being especially rapid at temperatures above 650 deg. cent.

A brief review of some of the previous work on expansion is included. Copies may be obtained by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents per copy.

Forest Products A1-22. Technical Notes. For the past three years and more the Forest Products Laboratory of the U. S. Forest Service has issued technical data sheets ($8 \times 10^1/_2$ in.) which cover a variety of subjects of special interest to the manufacturer, dealer and user of lumber, wood and wood products.

Many of these Technical Notes are of interest to mechanical engineers. A few of the subjects are therefore listed below by way of illustration. A-3, How to Make Factory Roof Timbers Last Longer; B-3, Metal Strapping on Wooden Boxes; B-9, Preparation of Stock for Bending; B-10, The Nailing of Boxes; 92, When to Heat Wood Before Gluing; 98, Fuel Value of Wood; 101, Comparative Value of Timber Cut from Live and Dead Trees; 105, What Is Dry Rot? 106, Making Wood Fire-Resistant with Paint; 110, Saving Mine Timbers from Decay; 130, Tie Renewals in Relation to Average Life; 134, The Crate Corner; 149, Strength of Screw Fastenings in Plywood; 121, Automatic Control of Humidity in Shops; and 122, Comparison of Five Different Types of Glue.

Fuels, Gas, Tar and Coke A9-22. The Ignition Temperature of Coal. Bulletin No. 128 of the University of Illinois Engineering Experiment Station, just issued, is a careful study of this subject by Ray W. Arms.

In his introduction he states that there is no definite temperature at which coal bursts into flame. The phenomenon of flame from coal is due to the combustion of volatile matter driven off from the coal, the character of such matter varying under different conditions; hence the temperature at which the coal flames varies widely and is dependent upon surrounding conditions, and therefore the flaming temperature of a coal does not serve as an indication of the ignition point. Strictly speaking, it is the true ignition point, but since it varies so widely its evaluation is meaningless.

The first purpose of this investigation, therefore, was to establish some definite point along the line of this process of heating which could be called the ignition temperature. In the effort to locate such a temperature heating curves were drawn to show the rate at which the coal increased in temperature when assisted by an outside source of heat. After a study of these curves the point at which the coal assumed a uniform glow was chosen as the most logical ignition temperature, not only because this point was found to be rather definite in the heating curve, but also because it could be checked in various types of apparatus by different means of temperature measurement and control, and by different operators.

Mr. Arms' five conclusions are:

1 The "ignition temperature" of coal means nothing unless it is applied to some definite point in the process of heating the coal, which can easily be determined and duplicated.

2 The temperature at which the coal glows seems to be the most logical point to choose as the ignition temperature. It is easily observed, can be duplicated with a fair degree of accuracy, and marks the beginning of visible combustion.

3 The glow point is probably affected by the oxygen content of the coal, and perhaps by other agencies made active by weathering.

4 The glow point is not affected by ash, moisture, size of particles, slight variations from the normal air supply, or rate of heating.

5 There is no indication at present that the glow point bears any direct relation to the liability to fire while in storage. Perhaps if a series of tests were made on the glow points of freshly mined coal new information would be brought to light which would lead to the discovery of some more definite relation between glow point and the firing qualities of the coal.

Internal-Combustion Engines A1-22. The Background of Detonation. This is the subject of Technical Note No. 93 recently prepared by the National Advisory Committee for Aeronautics. It has for its object the discussion of a phase of this question which so far has received but little attention. The effect of the temperature and pressure of the charge before combustion is especially considered, as it is believed that a careful study of this "background" can throw considerable light on results that have been obtained in investigations of detonation both at the Bureau and elsewhere.

The circumstances under which detonation occurs are described, and the effects of varying conditions in the engine are discussed. The work of Harry R. Ricardo in England receives a great deal of attention, and it is believed that additional facts have been deduced from the data which he obtained.

It is shown that compression and explosion pressures, scavenging, and the operation of the ignition system all play a prominent part in the phenomenon of detonation. The influence of changes in fuel characteristics is believed to lie outside the province of this paper and is not taken up in any detail.

Preignition and detonation are conceded to be entirely independent phenomena, and it is shown that overheating troubles are more likely to be from preignition than from detonation. Curves and diagrams illustrating various phases of the subject are presented, and the whole forms a valuable contribution to the study of the internal-combustion engine. Those desiring copies should write directly to the above-named committee at 2722 Navy Building, Washington, D. C.

Iron and Steel A2-22. Thermal Expansion of a Few Steels. See *Expansion A1-22.*

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Automotive Vehicles and Equipment B2-22. Power Loss in Automobile Tires. The rubber laboratory of the Bureau of Standards is equipped with a special dynamometer for determining, among other things, the power loss in automobile tires. A great many of the standard makes of tires have been tested on this dynamometer, and valuable data are being obtained concerning the percentage of the power of an automobile engine which is absorbed by the tires under various conditions.

Some interesting figures have already been secured as a result of this work. For instance, an average 4-in. fabric tire, under conditions of normal load and air pressure, will absorb approximately 0.90 hp. due to rolling resistance at a speed of 25 miles per hour. Under the same conditions, the power loss in a 4-in. cord tire is approximately 0.60 hp., while a 5-in. cord tire represents a loss of 1.20 hp. The extent to which different parts of the tire contribute to the power loss has also been investigated. It is estimated that from 80 to 85 per cent of this loss is in the carcass, the tread contributes 10 to 15 per cent, and the tube probably less than 5 per cent.

Boilers B1-22. Specifications for Refractories. See *Refractories B1-22.*

Corrosion B3-22. Resistance of Chromium Steels to Atmospheric Corrosion. For resisting corrosion by water and air, a considerable amount of chromium in a steel is necessary, and alloys of this general type were found much more resistant than were those of low chromium content. These latter steels, however, were found much more resistant than the simple carbon steel or "pure" iron. Hardening the chromium steel by heat treatment retarded corrosion by water and air as it did in the acid tests. This was true, in particular, for the steels of high chromium content, while variations in heat treatment produced very little difference in resistance to corrosion in specimens lower in chromium. Adhering patches of oxide scale upon the surface were found to have a very noticeable effect in accelerating the rate of attack of the chromium steels.

The alloy containing a high percentage of nickel, as well as chromium, found to be attacked the least by acid, also proved much more resistant to atmospheric corrosion than most of the chromium steels tested, although it was far surpassed by certain of the high-chromium materials.

In most cases corrosion of the chromium steels consisted in an attack at small isolated spots rather than in a general tarnishing and coating of the surface. This, in view of the fact that adhering particles of scale accelerate the corrosive attack of a steel to a very marked degree, suggests that the presence of inclusions or other defects within the material may be responsible in large measure for the character of the resulting surface pattern.

The character of the service should govern the type of "non-corrodible" steel to use. For example, if resistance to severe acid attack is the principal requirement, a high-chromium steel is the least suitable of all the materials tested. However, most classes of service require fairly satisfactory performance under a variety of conditions. Thus, for example, cutlery steel must withstand *both* acid and atmospheric corrosion as well as possess certain necessary mechanical properties, "forgeability," hardness, etc. No single type of non-corrodible steel appears to be suitable for each and every purpose which may arise. Address Dr. S. W. Stratton, Director, Bureau of Standards, Department of Commerce, Washington, D. C.

Non-Ferrous Metals B1-22. Spectroscopic Analysis of Bronzes. An examination of five bronzes for impurities for the purpose of establishing the spectrographic method for quantitative estimation of small amounts of aluminum and silicon which are detrimental in bronze or brass castings has been recently undertaken by the Bureau of Standards. A progress report on this practical application of spectrum analysis was presented at the Nonferrous Metals Committee Meeting on April 24.

Refractories B1-22. Specifications for Refractories. At the last meeting of the Bureau of Standards Advisory Committee on specifications for refractories, it became evident that additional investigation would be necessary to determine what test requirements are most effective in drawing the line between satisfactory and unsatisfactory brick for furnace linings in stoker-fired boilers. As a result preparations are being made to conduct an extended series of tests, including a 72-hour reheating test at 1450 deg. cent. A prominent consulting engineer is coöperating with the Bureau in this work and in addition to gathering information as to the suitability of different brands of brick, is arranging to have a quantity of samples representing about 20 brands shipped to the Bureau of Standards by the users.

Rubber and Allied Substances B1-22. Power Loss in Automobile Tires. See *Automotive Vehicles and Equipment B2-22.*

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Forest Products F1-22. Preservation of Mine Timber. This bibliography, prepared by R. R. Hornor for the Bureau of Mines, consists of six closely typewritten pages 8×10½ in. in size. It is known as Serial No. 2343 and may be obtained by addressing H. Foster Bain, Director, Department of the Interior, Bureau of Mines, Washington, D. C.

Petroleum and Allied Substances F3-22. A List of Recent Articles. This bibliography lists under eleven headings the literature on this subject which was published during the months of March and April. The compiler is E. H. Burroughs, Bibliographer of the Bureau of Mines. It is one of the Bureau's Reports of Investigations, Serial No. 2348.

Wood Products (other than Cellulose and Paper) F1-22. Preservation of Mine Timber. See *Forest Products F1-22.*

Second Revision of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be cordially invited to attend and present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

The revisions which have met the approval of the Boiler Code Committee are here published. It is the request of the Committee that these revisions be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

The revisions here published are limited to the paragraphs appearing in the 1918 Edition of the A.S.M.E. Boiler Code, and the paragraph numbers refer to the paragraphs of similar number in that edition. For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

Note: Matter deleted, in smaller type; matter added, in small capitals.

Par. 9 Revised:

9 Cross pipes connecting the steam and water drums of water-tube boilers, headers, cross boxes and all pressure parts of the boiler proper over 2-in. pipe size, or equivalent cross-sectional area, shall be of wrought steel, or cast steel of Class B grade, as designated in the Specifications for Steel Castings, when the maximum allowable working pressure exceeds 160 lb. per sq. in. THE USE OF BESSEMER STEEL IS PROHIBITED FOR THE PRESSURE PARTS OF BOILERS. Malleable iron may also be used when the maximum allowable

working pressure does not exceed 200 lb. per sq. in., provided the form and size of the internal cross-section perpendicular to the longest dimension of the box, is such that it will fall within a 7 in. by 7 in. rectangle.

Par. 12 Revised:

12 Cast iron shall not be used for nozzles or flanges attached directly to the boiler for any pressure or temperature. CAST IRON SHALL NOT BE USED [nor] for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. fahr.

Par. 20 Revised:

20 The minimum thicknesses of tube sheets for FIRE-TUBE [horizontal return tubular] boilers, shall be as follows:

When the diameter of tube sheet is

42 In. or under	Over 42 in. to 54 in.	Over 54 in. to 72 in.	Over 72 in.
$^3/_8$ in.	$^7/_{16}$ in.	$^1/_2$ in.	$^9/_{16}$ in.

Par. 25 Revised:

25 *Chemical Composition.* The steel shall conform to the following requirements as to chemical composition:

	Flange	Firebox
Carbon	Plates $^3/_4$ in. thick and under—NOT OVER [0.12] 0.25 per cent Plates over $^3/_4$ in. thick—NOT OVER [0.12] 0.30 per cent	
Manganese	0.30–0.60 per cent	0.30–0.50 per cent
Phosphorus, Acid.	Not over 0.05 per cent	Not over 0.04 per cent
Phosphorus, Basic.	Not over 0.04 per cent	Not over 0.035 per cent
Sulphur	Not over 0.05 per cent	Not over 0.04 per cent

Par. 29 Revised:

29 *Modifications in Elongation.* *a* For material over $^{11}/_{16}$ in. in thickness: From the figure representing the percentage of elongation required as determined in accordance with Par. 28 *a*, there shall be deducted an amount equal to four times the difference between the ordered thickness in inches and $\frac{3}{4}$ [$^{11}/_{16}$] in., except that the minimum elongation required shall in no case be less than 20 per cent.

b For material $^1/_4$ in. in thickness, the elongation shall be measured on a gage length of 6 in.

Par. 36 Revised:

36 *Marking.* *a* Each shell plate shall be legibly stamped by the manufacturer with the melt or slab number, name of manufacturer, grade and the minimum tensile strength of the stipulated range as specified in Par. 28, in TWO [three] places, [two of] which shall be located NOT LESS THAN [at diagonal corners about] 12 in. from the edge [and one about the center] of the plate, or at TWO [a] points selected and designated by the purchaser so that AT LEAST ONE [the] stamp shall be plainly visible when the boiler is completed.

b Each head shall be legibly stamped by the manufacturer in two places, about 12 in. from the edge, with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range as specified in Par. 28, in such manner that the stamp is plainly visible when the boiler is completed.

c Each butt strap shall be legibly stamped by the manufacturer in two places on the center line about 12 in. from the ends with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range as specified in Par. 28.

d The melt or slab number shall be legibly stamped on each test specimen.

Add the Following to Par. 36:

e IT IS PERMISSIBLE TO TRANSFER, WITHOUT IMITATION, THE MARKINGS ON THE PLATE UNDER AUTHORITY OF AN AUTHORIZED INSPECTOR IN CHARGE; SAID INSPECTOR TO PUT HIS PRIVATE MARK AFTER THE TRANSFERRED STAMP.

f IF, DURING FABRICATION IN THE BOILER SHOP, REMOVAL OF BOTH GROUPS OF THE PLATE MANUFACTURER'S STAMPS CANNOT BE AVOIDED BECAUSE OF THE CUTTING OR PUNCHING OF NECESSARY HOLES IN THE PLATES, ONE GROUP OF SUCH STAMPS MAY BE TRANSFERRED TO A PERMANENT POSITION BY RESTAMPING UNDER THE SUPERVISION OF AN AUTHORIZED STATE, MUNICIPAL OR INSURANCE COMPANY INSPECTOR. WHEN STAMPS ARE TRANSFERRED THE PLATE MANUFACTURER'S NAME SHALL NOT BE IMITATED. THE INSPECTOR SHALL PUT HIS PRIVATE STAMP BESIDE THE TRANSFERRED GROUP AND A RECORD OF THE TRANSFER AND THE INSPECTOR'S STAMP SHALL BE NOTED ON THE DATA SHEET. A GROUP OF STAMPS CONSISTS OF THE MANUFACTURER'S NAME, MANUFACTURER'S TEST IDENTIFICATION NUMBER, GRADE AND TENSILE STRENGTH.

Par. 48 Revised:

IV Permissible variations in gage

48 The gage of each bar shall not vary more than 0.01 in. from that specified.

Par. 180 Add following paragraph:

THE FACTOR OF SAFETY USED IN DETERMINING THE MAXIMUM ALLOWABLE WORKING PRESSURE CALCULATED ON THE CONDITIONS ACTUALLY OBTAINED IN SERVICE SHALL NOT BE LESS THAN 5.

Par. 182 Revised:

182 The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

a If $\frac{P}{[D]d}$ is 4 or less, the minimum value shall be 2[D]d;

b If $\frac{P}{[D]d}$ is over 4, the minimum value shall be:

$$2[D]d + 0.1\,(P - 4[D]d)$$

where

P = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, in.

P = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row, in. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced.)

[D]d = diameter of the rivet holes in.

Par. 194 Revised:

194 *Domes.* THE REQUIREMENTS OF PARS. 187 AND 188 SHALL APPLY TO RIVETED LONGITUDINAL JOINTS OF DOMES EXCEPT THAT FOR DOMES 24 IN. AND LESS IN DIAMETER FOR PRESSURES EXCEEDING 100 LB., THE LONGITUDINAL JOINTS MAY BE LAP-RIVETED IF THE FACTOR OF SAFETY IS NOT LESS THAN 8. [The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction, irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in., the flange of a dome 24 in. or over in diameter shall be double-riveted to the boiler shell.]

THE FLANGE OF A DOME 24 IN. OR OVER IN DIAMETER SHALL BE DOUBLE-RIVETED TO THE BOILER SHELL. WHERE THE FLANGE OF THE DOME IS USED FOR REINFORCING OR ATTACHING IT TO THE SHELL, THE DIAMETER OF THE DOME SHALL NOT EXCEED ONE-HALF THE DIAMETER OF THE SHELL OR BARREL OF THE BOILER. [The longitudinal joint of a dome less than 24 in. in diameter may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome is computed with a factor of safety of not less than 8.]

The dome may be located on the barrel or over the fire-box on traction, portable or stationary boilers of the locomotive type up to and including 48 in. barrel diameter. For larger barrel diameters, the dome shall be placed on the barrel.

Flanges of domes shall be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plate for plates over 1 in. in thickness.

Par. 201 Revised:

201 *Structural Reinforcements.* When channel irons or other members are securely riveted to the boiler heads for attaching through stays, the transverse stress on such members shall not exceed 12,500 lb. per sq. in. In computing the stress, the section modulus of the member shall be used without addition for the strength of the plate. The spacing of the rivets over the supported surface shall be DETERMINED BY THE FORMULA IN PAR. 199 USING 135 FOR THE VALUE OF C [in conformity with that specified for staybolts.]

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of these rivets attaching

the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

PAR. 205 REVISED

205 The distance from the edge of a staybolt hole to a straight line tangent to the edges of the rivet holes may be substituted for p for staybolts adjacent to the riveted edges bounding a stayed surface. When the edge of a FLAT stayed plate is flanged AND RIVETED, THE DISTANCE FROM THE CENTER OF THE OUTERMOST STAYS TO THE INSIDE OF THE SUPPORTING FLANGE SHALL NOT EXCEED THE PITCH OF THE STAYS, p, PLUS THE INSIDE RADIUS OF THE FLANGE [p shall be measured from the inner surface of the flange, at about the line of rivets to the edge of the staybolts or to the projected edge of the staybolts.]

PAR. 206 REVISED:

206 The MAXIMUM PITCH p AS GIVEN IN PAR. 199 [distance between the edges of the staybolt holes] may be INCREASED BY THE STAYBOLT HOLE DIAMETER WHERE [substituted for p for] staybolts ARE adjacent to a furnace door or other boiler fitting, tube hole, handhole or other opening.

PAR. 212c REVISED:

c A FURNACE FOR A VERTICAL FIRE-TUBE BOILER, 38 IN. OR LESS IN OUTSIDE DIAMETER, WHICH REQUIRES STAYING, SHALL HAVE THE FURNACE SHEET SUPPORTED BY ONE ROW OF STAYBOLTS, OR MORE, THE CIRCUMFERENTIAL PITCH NOT TO EXCEED 1.05 TIMES THAT GIVEN BY THE FORMULA IN PAR. 199 AND IN TABLE 4.

THE LONGITUDINAL PITCH BETWEEN THE STAYBOLTS, OR BETWEEN THE NEAREST ROW OF STAYBOLTS AND THE ROW OF RIVETS AT THE JOINTS BETWEEN THE FURNACE SHEET AND THE TUBE SHEET OR THE FURNACE SHEET AND MUD RING, SHALL NOT EXCEED THAT GIVEN BY THE FOLLOWING FORMULA:

$$L = \frac{(220 \times T^2)^2}{(P \times R)}$$

EXCEPT WHEN THIS VALUE IS LESS THAN THE CIRCUMFERENTIAL PITCH, IN WHICH CASE THE LONGITUDINAL PITCH MAY BE AS GREAT AS THE ALLOWABLE CIRCUMFERENTIAL PITCH

where

L = LONGITUDINAL PITCH OF STAYBOLTS
T = THICKNESS OF FURNACE SHEET IN SIXTEENTHS OF AN INCH
P = MAXIMUM ALLOWABLE WORKING PRESSURE IN LB. PER SQ. IN.
R = OUTSIDE RADIUS OF FURNACE, IN INCHES.

THE STRESS PER SQUARE INCH IN THE STAYBOLTS SHALL NOT EXCEED 7500 LB. AND SHALL BE DETERMINED IN THE WAY SPECIFIED IN PAR. 212d.

PAR. 212d INSERT NEW SECTION AS FOLLOWS:

d FOR FURNACES OVER 38 IN. IN OUTSIDE DIAMETER OF VERTICAL FIRE-TUBE BOILERS AND OTHER TYPES OF FURNACES AND COMBUSTION CHAMBERS NOT COVERED BY SPECIAL RULES IN THIS CODE, WHICH HAVE CURVED SHEETS SUBJECT TO EXTERNAL PRESSURE, THAT IS, PRESSURE ON THE CONVEX SIDE, THE STAYING, BOTH CIRCUMFERENTIAL AND LONGITUDINAL, SHALL BE PROVIDED FOR IN ACCORDANCE WITH THE FOLLOWING FORMULA:

$$P = \frac{CT^2}{p^2} + 250\frac{T}{R}$$

WHERE p AND THE VALUE OF C ARE AS GIVEN IN PAR. 199, p SHALL NOT EXCEED 2T, AND p^2 SHALL NOT EXCEED 0 008CTR.

THE STRESS PER SQ. IN. IN STAYBOLTS SHALL NOT EXCEED 7500 LB., BASED ON A TOTAL STRESS OBTAINED BY MULTIPLYING THE PRODUCT OF THE CIRCUMFERENTIAL AND LONGITUDINAL PITCHES BY $(P - 250\frac{T}{R})$.

PAR. 217 REVISED:

217 The net area to be stayed in a segment of a head may be determined by the following formula:

$$\frac{4(H - d - 2)^2}{3}\sqrt{\frac{2(R - d)}{(H - d - 2)}} - 0.608 = \text{area to be stayed, sq. in.}$$

where

H = distance from tubes to shell, in.
d = distance DETERMINED [given] by formula in Par. 214.
R = radius of boiler head, in.

PAR. 243 IN THE CONSTANT C FOR MORISON FURNACES, CHANGE TO READ AS FOLLOWS:

C = 15,600 a constant for *Morison furnaces*, when corrugations are not MORE [less] than 8 in. from center to center and the radius of the outer corrugations is not more than one-half that of the suspension curve.

PAR. 247 REVISED:

247 Where NO RULES ARE GIVEN AND it is impossible to calculate with a reasonable degree of accuracy the strength of a boiler structure or any part thereof, a full-sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test. IN SUCH A STEEL-PLATE OR CAST-STEEL STRUCTURE, THE PRESSURE CORRESPONDING TO THE YIELD POINT SHALL BE ACCURATELY DETERMINED AND THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL NOT EXCEED THAT OBTAINED BY DIVIDING THIS PRESSURE BY 2.5. SUCH STRUCTURES WHEN OF CAST IRON SHALL BE TESTED TO THE BURSTING POINT.

PAR. 250 REVISED:

250 A fire-tube boiler WITH TUBES UNDER 5 IN. DIAMETER shall have [both ends of] the tubes [substantially] rolled and beaded, or rolled and welded at the firebox or combustion-chamber end, AND ROLLED AND BEADED AT THE OTHER END. IN THE CASE OF TUBES UNDER $1^1/_4$ IN. DIAMETER, THE TUBES MAY BE EXPANDED BY THE PROSSER METHOD IN PLACE OF ROLLING. IN THE CASE OF TUBES 5 IN. IN DIAMETER AND OVER, THE TUBES SHALL BE SECURED BY RIVETING OR OTHER APPROVED METHOD AT BOTH ENDS.

PAR. 252 REVISED:

252 The ends of all tubes, suspension tubes and nipples of water-tube boilers and superheaters shall project through the tube sheets or headers not less than $^1/_4$ in. nor more than $^1/_2$ in. before flaring. WHERE THE TUBES ENTER AT AN ANGLE, THE MAXIMUM LIMIT OF $^1/_2$ IN. SHALL APPLY ONLY AT THE POINT OF LEAST PROJECTION.

PAR. 253 REVISED:

253 *Drilling of Holes.* All rivet holes and staybolt holes and holes in braces and lugs shall be drilled [full size] or they may be punched not to exceed $^1/_4$ in. less than full diameter for material over $^5/_{16}$ in. AND NOT EXCEEDING $^5/_8$ IN. in thickness, and $^1/_8$ in. less than full diameter for material not exceeding $^5/_{16}$ in. in thickness [and then drilled or reamed to full diameter.] FOR FINISHING THE RIVET HOLES, THE plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for FINAL drilling or reaming TO FULL DIAMETER [all rivet holes in boiler plates except those used for the tack bolts.] THE FINISHED HOLES MUST BE TRUE, CLEAN AND CONCENTRIC. HOLES SHALL NOT BE PUNCHED IN PLATE OVER $^5/_8$ IN. THICKNESS.

PAR. 259 REVISED:

259 A manhole reinforcing ring when used, shall be of steel or wrought-iron, and shall be at least as thick as the shell plate THICKNESS REQUIRED BY PAR. 180.

PAR. 260 REVISED:

260 Manhole frames on shells or drums when used, shall have the proper curvature, and on boilers over 48 in. in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. 21. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength (REQUIRED BY PAR. 180) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening.

PAR. 268 REVISED:

268 *Threaded Openings.* ALL PIPE THREADS SHALL CONFORM TO THE AMERICAN PIPE STANDARD AND ALL [a pipe] connections 1 in. in diameter or over shall have not less than the number of threads given in Table 8.

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 100 lb. per sq. in., a NOZZLE OR SADDLE FLANGE [connection] riveted to the boiler to receive a flanged fitting shall be used for all pipe openings over 3 in. pipe size.

PAR. 299 REVISED:

299 [Nozzles and] *Fittings.* Flanged cast iron pipe fittings used for boilers, [parts,] for pressures up to and including 160 lb. per sq. in., shall conform to the American Standard given in Table [s] 16 of the Appendix, FOR PRESSURES UP TO 50 LB. and Table 17 FOR ALL HIGHER PRESSURES AND FOR STEAM, FEED AND BLOW-OFF PIPES UP TO THE STOP VALVE, except that the face of the flange of a safety valve as well as that of a safety valve nozzle, may be flat and without the raised face.

(Note: Balance of paragraph remains unchanged.)

PAR. 307 REVISED:

307 *Blow-off Piping.* A surface blow-off shall not exceed $1^1/_2$ in. pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing SIMILAR TO OR EQUIVALENT OF THOSE [as] shown in Fig. 22, or a flanged connection, shall be used.

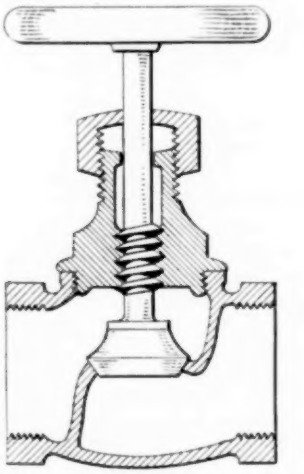

FIG. $22^1/_2$ TYPE OF GLOBE VALVE

PAR. 308 REVISED:

308 Each boiler shall have a bottom blow-off pipe, fitted with a valve or cock, in direct connection with the lowest water space practicable; the minimum size of pipe and fittings shall be 1 in. and the maximum size shall be $2\frac{1}{2}$ in. STRAIGHTWAY GLOBE VALVES OF THE ORDINARY TYPE AS SHOWN IN FIG. $22\frac{1}{2}$, OR VALVES OF SUCH TYPE THAT DAMS OR POCKETS CAN EXIST FOR THE COLLECTION OF SEDIMENT, SHALL NOT BE USED ON SUCH CONNECTIONS. [Globe valves shall not be used on such connections.]

PAR. 314 REVISED:

314 *Feed Piping.* The feed pipe of a boiler shall have an INTERNAL DIAMETER NOT LESS THAN $\frac{3}{4}$ IN. [open end or ends inside of the boiler.]

PAR. 325 REVISED:

325 Lugs or brackets, when used to support a boiler of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16. WHERE IT IS IMPRACTICAL TO USE RIVETS, STUDS WITH NOT LESS THAN 10 THREADS PER INCH MAY BE USED. IN COMPUTING THE SHEARING STRESSES, THE AREA AT THE BOTTOM OF THE THREAD SHALL BE USED. [For traction or portable boilers, studs with pipe threads may be used.]

FIG. 32 REVISED:

A Change dimension line to center of stayrod.
D Change dimension line to center of staybolt.
F Change dimension line to center of door ring rivet.
H Give eighth sketch in drawing the designation "H."

PAR. 423 CHANGE SECOND SECTION TO READ AS FOLLOWS:

A bevel-seated $3^1/_2$ in. valve WITH [is marked by the manufacturer] 0.11 in. lift HAS A [and] discharge capacity AT [for] 100 lb. pressure OF [=] 4840 lb.; hence two such valves would be required.

PAR. 424 CHANGE SECOND SECTION TO READ AS FOLLOWS:

A bevel-seated $2^1/_2$ in. valve WITH [is marked by the manufacturer] 0.08 in. lift HAS A [and] discharge capacity AT [for] 275 lb. pressure OF [=] 6350 lb.; hence two such valves would be required.

Fusible Plugs.

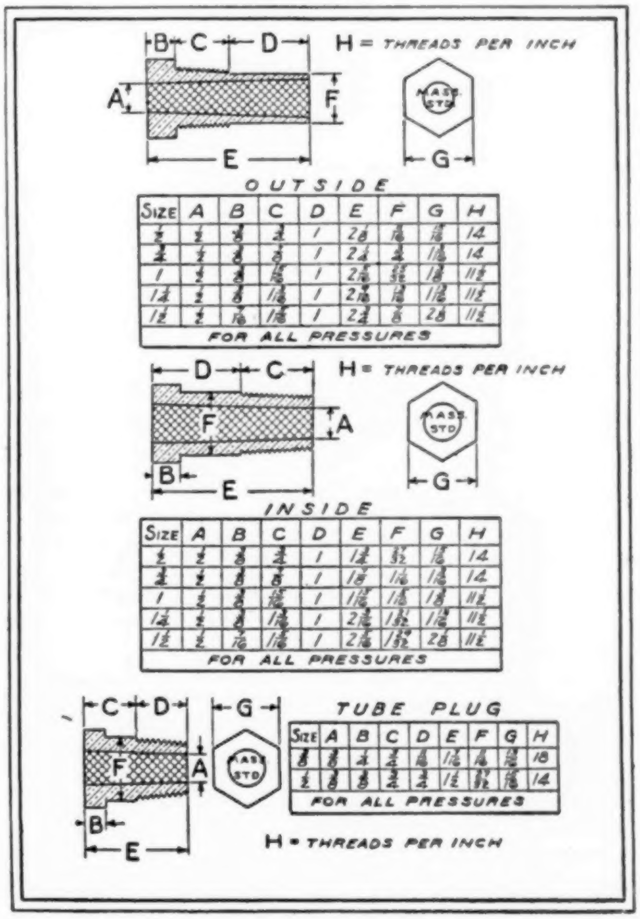

FIG. $33^1/_2$ ACCEPTABLE FORMS OF FUSIBLE PLUGS

PAR. 425 CHANGE SECOND SECTION TO READ AS FOLLOWS:

A bevel-seated 2 in. valve WITH [is marked by the manufacturer] 0.07 in. lift HAS A [and] discharge capacity AT [for] 150 lb. pressure OF [=] 2500 lb.; hence one such valve would be required.

TABLE 16 CHANGE TITLE TO READ AS FOLLOWS:

AMERICAN STANDARD 125-LB. WORKING PRESSURE PER SQ. IN. STANDARD CAST-IRON FLANGE FITTINGS, STRAIGHT SIZES (SEE FIG. 33).

TABLE 17 CHANGE TITLE TO READ AS FOLLOWS:

AMERICAN STANDARD, 250-LB. WORKING PRESSURE PER SQ. IN., EXTRA HEAVY CAST-IRON FLANGE FITTINGS, STRAIGHT SIZES (SEE FIG. 33).

PAR. 428 REVISED:

428 Fusible plugs, if used, shall be filled with tin with a melting point between 400 and 500 deg. fahr., and shall be renewed once each year. WHERE THE BOILERS ARE TO BE OPERATED AT WORKING PRESSURES IN EXCESS OF 225 LB. PER SQ. IN. GAGE, THE USE OF FUSIBLE PLUGS IS NOT ADVISABLE.

Interesting Discussion at Atlanta Sessions

American Welding Society Assists in A.S.M.E. Spring Meeting Session on Welded Pressure Vessels—Professional Divisions on Fuels, Machine Shop, Management, Materials Handling, Power and Textile Coöperate in Program

SIX of the A.S.M.E. Professional Divisions coöperated in providing the technical sessions at the Atlanta Spring Meeting. The papers were all in hand by March 15 and this insured the printing and issue of the papers two weeks before the meeting. The resulting carefully prepared discussion added greatly to the interest and value of the technical sessions.

In accordance with the procedure of the past few years, a running account of the discussion is given in this issue of MECHANICAL ENGINEERING. Complete discussion will appear in the Transactions of the Society.

TEXTILE-MACHINERY SESSIONS

UNDER the auspices of the Textile and Machine-Shop Practice Divisions sessions were held on Tuesday and Wednesday mornings, May 9 and 10. At the first meeting two papers were presented: Cotton-Ginning Machinery, by S. E. Gillespie, and Maintenance of Textile Machinery, by E. H. Marble. On Wednesday three papers: Weaving Machinery, by L. B. Jenckes; Extraction of Oil from Vegetable Matter, by Jos. Davidson, and Modern Shop Practice in the Building of Revolving Flat Cards, by F. E. Banfield, Jr., were considered. All of these papers have been recently published in MECHANICAL ENGINEERING. H. M. Latham presided on both occasions.

In discussing Mr. Gillespie's paper, W. E. Caldwell[1] stated that the usual operating troubles encountered by cotton ginners are due to the too frequent use of set screws and clamped joints by the gin manufacturers instead of keys, to overloaded belts produced by the use of small pulleys and low belt speeds, and finally, to fans and their piping arrangement. The margin of safety on peripheral speed of fans in modern practice is too low. Air-blast gins have apparently been developed to accommodate the fans now on the market, whereas a fan should be designed to better meet the requirements of ginning systems. A fan somewhat on the order of the cupola blower, which has a better pressure-volume characteristic than the usual volume fan, as well as greater efficiency, might be advantageously employed, although the efficiency is relatively unimportant considering the low annual load factor of ginning plants. He asked whether the belt distributor had any real advantages over the pneumatic elevator, considering power saving, greater simplicity, ease of operation and saving of time between bales.

In another written discussion of this paper, A. W. Merkel[2] compared the single- and double-rib huller gins and presented figures on the power requirements of air-blast and brush gins. He also pointed out that while cotton gins are classed as agricultural implements, which as a class usually do not demand close machine work, the ribs, saws and space blocks which separate the saws, are parts necessitating accurate machining.

After the reading of the paper by Mr. Marble, the discussion was opened by R. A. Packard[3] who stated that the time must soon come when the lubrication of textile bearings will be done on a more efficient basis and while ball bearings on textile machinery are filling a great need today, the question as to whether they should supplant babbitt or brass friction metals is still unsettled.

W. H. Holby[4] discussed the subject from the ball-bearing manufacturer's viewpoint and in summing up his comments claimed that ball bearings require very little attention; that they effect a considerable saving in horsepower, varying with the application and type of machine; that savings in lubrication and maintenance costs are often sufficient to justify the entire expense of ball-bearing equipment, and that ball bearings improve the quality of the textile product.

The incorrectness of the idea that ball bearings are the cure for all operating troubles was then set forth by A. F. MacIntyre,[5] who advocated a specific remedy determined for and applied to each case rather than a general one for all ills.

Speaking from the viewpoint of the textile-machinery manufacturer, F. E. Banfield, Jr.,[6] said that there were certain bearings well suited for the application of ball bearings while others were not. On cards, ball bearings are not desirable since the properly designed plain bearing is simpler and will give less trouble in the long run. The average mill management puts too little importance on the subject of lubrication, whereas the life of a textile machine depends almost wholly upon the life of its bearings. Mr. Banfield placed roller bearings in the category of ball bearings, but considered them better suited for lineshafts, trucks, cranes or bearings subject to heavy loads and severe working conditions.

SECOND SESSION

The Wednesday session was opened by the presiding officer, Mr. Latham, who read abstracts from Mr. Jenckes' paper and described slides shown in connection therewith. In the discussion, C. H. Fish[7] questioned whether velvets are woven double and cut, since then, strictly speaking, it is not velvet but some type of plush. The distinct difference between the two is that plush is cut with a knife and not necessarily woven double and cut from the loom, while velvet, being much finer fabric, is cut as it is woven.

Mr. Davidson supplemented his paper with a detailed account of the development, operation and construction of his high-pressure yielding-plunger pump which gives a greater efficiency in oil extraction and saving in press cloth than with the hydraulic method. The discussion which followed centered around the cotton seed and the use and extraction of its oil on a commercial basis. The author stated that to every 1500 lb. of unginned cotton there was 1000 lb. of seed and the cotton-seed oil industry is secondary to the textile business in the cotton districts. From 1000 lb. of cotton seed 150 lb. of crude oil is obtained, and with the refining loss 6 to 10 per cent the net amount of refined oil is about 130 lb.

After explaining that picking or removing seed, leaf and other foreign matter from ginned cotton is the first process through which cotton is put in the mill and that carding is simply a further cleaning process to take out any short fly or staple which is undesirable in the making of a good yarn, Mr. Banfield presented his paper. He covered his subject very thoroughly and showed numerous slides. In the discussion, Mr. Fish called attention to the omission of mention of the old American drop card which was in use in this country prior to the production of revolving flat cards.

MATERIALS HANDLING SESSION

THE Materials Handling Division held its session on Tuesday morning, May 9, with R. M. Gates presiding. Only one paper, that entitled Material Handling Equipment as Used in the Iron and Steel Industry, by F. L. Leach, was scheduled. As the author is in India the paper was presented by F. L. Estep,[8] a former associate. The paper will be published in a future number of MECHANICAL ENGINEERING.

Mr. Estep read the entire paper and interspersed detailed ex-

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[1] United Electric Light & Power Co., New York. Jun. Mem. Am.Soc. M.E.

[2] Supt., Continental Gin Co., Atlanta, Ga. Mem. Am.Soc.M.E.

[3] Supt. Power & Shops, Ludlow Mfg. Association, Ludlow, Mass. Mem. Am.Soc.M.E.

[4] Dist. Mgr., SKF Industries, Inc., Atlanta, Ga. Jun. Mem. Am.Soc. M.E.

[5] Agent, Fulton Bag & Cotton Mills, Atlanta, Ga. Mem. Am.Soc.M.E.

[6] Supt., Saco-Lowell Shops, Newton Upper Falls, Mass. Mem. Am.Soc.M.E.

[7] Cons. Engr., Boston, Mass. Mem. Am.Soc.M.E.

[8] Chief Engr. and Partner, Perin & Marshall, New York. Mem. Am.Soc.M.E.

planations of interesting features. He called attention to the soaking-pit crane and the charging machine. In the combination rail and structural mill described in the paper where the rolling of rails is one problem and the rolling of shapes another, he pointed out the equipment arrangement in complete units of angle table, cut-off, throw-off, skid table, gag straightener, double enders and double drillers. The mechanical doubler, which does the work more accurately than manual labor and has thereby been instrumental in reducing the cost of tin-sheet metal, received special comment.

Discussion Questions Answered

In answering questions raised in the discussion Mr. Estep said that he doubted if a machine could be invented to open the packs, since this is a problem of 75 per cent rolling and 25 per cent heat and the human element was needed. In a steel plant the wages are on a tonnage basis and therefore all equipment should be designed and constructed to meet the practical requirements of the workers and not to meet theoretical conditions. Handling and moving is a large item in the cost of manufacturing steel and steps are being taken to reduce it.

Stafford Montgomery[9] asked about economical methods for conveying and storing large quantities of many sizes of light tubes in the finished condition between drawing operations, also whether steam locomotives can be economically eliminated from the yard proper of a steel company and electrical power used. In reply Mr. Estep stated that three or four methods can be applied in the handling of tubes between departments and storage between operations. A tube mill, as a rule, does not have overhead cranes in a big building but monorails can be installed which will quickly carry a good tonnage of hot or cold material. Or if it is cold tonnage, it can be handled with a magnet and a monorail. In regard to the question of steam against electricity, he said that the overhead-trolley system would interfere with the plant operation and a third-rail system, nine times out of ten, would be too expensive. Difficulties in the way of maintaining and safeguarding would offset the saving in operating economies.

E. L. Shaner[10] was of the opinion that the handling equipment in iron and steel plants could be divided into two classes, the largest of which is comprised of heavy and intricate machinery that requires the attention of engineers who specialize in that equipment. On the other hand, there are many operations which require simple mechanisms and hand labor, and the reduction of handling costs on these operations is of great interest to iron, steel, electrical and metallurgical engineers.

FIRST GENERAL SESSION

At the First General Session of the Spring Meeting, Edward R. Fish[11] presented in the absence of the author a paper on The Accuracy of Boiler Tests, by Alfred Cotton,[12] and C. C. Trump[13] a paper on Using Exhaust Energy in Reciprocating Engines which appeared in the June issue of Mechanical Engineering. Interest in the second paper was stimulated by the presence of Dr. Johann S. Stumpf, co-author of the paper and originator of the uniflow engine, who had investigated the principles set forth in the paper. The discussion of Mr. Cotton's paper appears directly after his paper in this issue, page 430. Earl F. Scott, of Atlanta, Manager of the Society, presided at this session.

Mr. Trump presented his paper with the aid of lantern slides which illustrated the important points he wished to bring out, and then introduced Dr. Johann Stumpf. Dr. Stumpf spoke of the uniflow locomotive which Mr. Trump had mentioned in presenting the slides. The uniflow locomotive, he said, had been in successful operation for a year. He described how he had changed completely the exhaust as usually designed, and told in considerable detail of the effect of an exhaust port designed to remove steam from the cylinder in the time available. He also spoke of the application he was making of this principle to a 6-cylinder automobile gas engine.

J. S. Coon[14] mentioned the hydraulic-ram analogy; and C. E. Coolidge[14a] told how the power of the Liberty motor had been increased by lengthening the exhaust pipe. J. T. Wikle[15] asked about the possibility of muffling a gas engine equipped with such an exhaust pipe. Mr. Trump pointed out that the exhaust pipe of such a design was in effect a muffler, and, in reply to a question by Roland B. Hall,[16] said that the gain in power of an ordinary steam engine had not been decided upon, as so far the only actual example in operation was that of the locomotive. The success with the locomotive pointed to gains in power at heavy load of over 10 per cent and at light loads of 3 per cent.

In answer to a question by Mr. Scott, Dr. Stumpf said that the greatest possibilities for gain lay with the gas engine rather than the steam engine, because the exhaust loss was larger.

In answer to a question about the gas turbine, Dr. Stumpf said that he considered the subject a serious one, and that he had the "most sincere pity for engineers who have to get up a gas turbine."

In answer to a question by Mr. Weaver, Mr. Trump said that the design of the exhaust nozzle was similar to the design of the turbine nozzle. It is simply to produce the velocity under the conditions of difference of pressure which exist during the exhaust period, this difference changing from instant to instant. In a multiple-cylinder engine the velocity can be used to produce a suction on another cylinder, but this is impossible in single-cylinder engines.

Donald B. Prentice[17] wrote that the paper suggested a fertile field of research for college laboratories.

FUEL SESSION

At the Fuel Session of the Spring Meeting three papers were presented: Reduction of Fuel Waste in the Steel Industry, by F. G. Cutler;[18] Boiler-Room Performance and Practice at Colfax Station, Duquesne Light Company, by C. W. E. Clarke,[19] and The Control of Boiler Operation, by E. A. Uehling.[20] Mr. Fred R. Low presided at the session. The first two of these papers have appeared in recent issues of Mechanical Engineering; Mr. Uehling's paper is published in this issue. A brief abstract of the discussion at the meeting follows.

Discussion of Mr. Cutler's Paper

Following the presentation of the paper by the author, a written discussion by F. J. Crolius[21] was read. He said that the author's suggestion of a method of balancing elements so that the smallest amount of added fuels will be consumed was an excellent one, but that there is at present no steel plant designed or operating with this objective in view. Fuels have always been an incident in production, he said, and conclusions based on present-day practice were of small value. He showed that, using figures of the best present-day practice, there is a deficit in the heat balance, although it is quite fair to assume that an ideal plant, designed with heat and power conservation in view, might be operated without firing additional fuel.

The author's suggestion of better-designed heating furnaces, while excellent for a projected plant, he said, was difficult to accomplish and hardly justified in the matter of investment. There was no question that heating furnaces, as usually operated, violated combustion laws, although these losses were small compared with others. Much might be done, he said, toward improving the conditions of operation which could result in saving heat.

[9] Cons. Engr., Detroit Engineering Co., Detroit, Mich. Jun. Mem. Am.Soc.M.E.

[10] Engineering Editor, *Iron Trade Review*, Cleveland, O. Assoc-Mem. Am.Soc.M.E.

[11] V. P., Heine Boiler Co., St. Louis, Mo. Mem. Am.Soc.M.E.

[12] Research Engr., Heine Boiler Co., St. Louis, Mo. Mem. Am.Soc.M.E.

[13] V. P., Humphreys Gas Pump Co., Syracuse, N. Y. Assoc-Mem. Am.Soc.M.E.

[14] Prof. of M.E., Supt. of Shops, Georgia School of Technology, Atlanta, Ga. Mem. Am.Soc.M.E.

[14a] Georgia School of Technology, Mem. Am.Soc.M.E.

[15] Purchasing Agt., M.E., Fulton Bag and Cotton Mills, Atlanta, Ga. Mem. Am.Soc.M.E.

[16] Cons. Engr., Hall Engineering Service, Chicago, Ill. Assoc-Mem. Am.Soc.M.E.

[17] Prof. of M.E., Lafayette College, Easton, Pa. Assoc-Mem. Am.Soc.M.E.

[18] Ch. Bureau of Steam Engr., Tenn. Coal, Iron & R. R. Co., Ensley, Alabama. Mem. Am.Soc.M.E.

[19] Dwight P. Robinson & Co., New York, N. Y. Mem. Am.Soc.M.E.

[20] Milwaukee, Wis. Life Mem. Am.Soc.M.E.

[21] Carnegie Steel Co., Homestead Steel Works, Munhall, Pa.

R. S. Sage[22] and E. Pragst[23] presented a written discussion in which they said that apparently those primarily interested in the power and blowing plants of the steel industry are confronted with two entirely different classes of problems: one in plants where there is available an excess of gas, etc., above power and blowing requirement, so that the design of these machines need not be influenced by the question of plant thermal economy, and the other in plants where there is a shortage of by-product fuel or would be unless high thermal economy is possible. The writers then mentioned some of the advancements made in generating-station design which had direct bearing on steel plants belonging to this second class.

F. L. Estep[24] wrote that conditions in steel plants were far from being ideal, and that one of the outstanding features of the subject was that there was generally more to be gained by proper operation of existing equipment than by the installation of additional equipment. He criticized some of the author's figures which he thought were somewhat out of line with blast-furnace practice in general throughout the country. He thought an efficiency of 65 per cent more generally obtained than one of 60 per cent, that 1250 deg. was too high a hot-blast temperature, and that the assumption of 55 cu. ft. of air per lb. of coke left little margin for leakage. In the author's table of horsepower, the figures for total gas and total boiler horsepower seemed higher than in ordinary practice. He believed that net tons of coke consumed was a better basis than tons of iron produced for figuring expected horsepower. He thought the subject a very timely one and one which had not been discussed sufficiently.

Walter N. Flanagan[25] wrote that the use of blast-furnace gas was the keystone of power economy in the steel plant, as it was easier to maintain high efficiency when burning blast-furnace gas than when burning coal. A good burner was essential to efficient combustion, and a good gas cleaner was another source of saving. Dry-cleaning methods offered the greatest savings, he said, because the sensible heat in 400-deg. gas was worth $22,000 per furnace per year in equivalent coal. Coke breeze screened out of the blast furnaces was being used successfully in plants. When burned in underfeed stokers, coke would produce slightly more than half as much steam per pound as good coal.

W. Trinks[26] wrote that there was danger that the conclusions drawn from the author's paper might be generalized and that readers might gain the impression that an economical blast furnace and steel plant could operate without coal and still use steam blowing equipment. The coke consumption of 2500 lb. assumed by the author was high for northern plants, he said, where 1800 lb. per ton of pig iron was a more reasonable figure. The effect of such a reduction in coke consumption was to decrease both the quantity and the heat value of the gas. As regards open-hearth furnace practice, he said, northern plants were using approximately equal quantities of hot pig iron and scrap, so that a ton of pig iron would certainly produce at least 1.5 tons of steel, which would result in a greater heat demand. The total effects would show a net deficiency of over 17 million B.t.u. per ton of pig iron, which must be supplied by the burning of coal. As the matter stands today, he wrote, he knew of no low-coke-ratio plant with blooming and finishing mills in which the blast-furnace and coke-plant fuel sufficed for the whole plant, unless gas blowing engines were used.

The author replied to the discussion as follows: "Mr. Crolius apparently overlooked the intention of this method of comparison of blast furnaces. He goes into some detail in showing that one plant will vary from another, and how this difference will be caused, depending on the type of equipment used.

"That is one view of the comparison, it is true, but there is no reason why the same plant cannot be compared day by day by the method suggested in the paper.

"He also stated that he did not believe it would be advisable to improve existing heating furnaces. In that respect I beg to differ very strongly with Mr. Crolius, as we have found that it is very necessary to improve the existing heating furnaces.

"Mr. Trinks brings out a formula in which he shows that the heat available from the gas per ton of iron varies materially with the coke consumption and is less than that given in the paper. The only difference between the figures is that the author uses 2500 lb. and Mr. Trinks 1800 lb. of coke per ton of pig iron. The author believes that the average lies between these figures and that 2500 lb. is closer to the average coke consumption of all furnaces in operation.

"Mr. Trinks also mentions the fact that in some open hearths a large percentage of scrap is used. This may be true for the particular furnaces that he has in mind, but if this ratio is maintained, practically one-third of the pig-iron steel would have to go back into scrap in order to make some more open-hearth steel.

"In regard to the point raised by Mr. Estep as to the omission of the allowance for leakage, the author's position is that leakage bears the same relation to inefficiency in either gas or coal, and it does not make any difference to the whole gas-furnace plant whether the gas inefficiency is in the boilers or stoves, or in throwing it away in the top of the furnace. The whole question resolves itself into how much can be got out of the surplus gas. We all differ in our assumptions. The figure of 55 cu. ft. per lb. of coke includes an allowance of probably 10 per cent of the theoretical figure, which is between 50 and 55 in most cases, and 55 includes a percentage for leakage."

Discussion of Mr. Clarke's Paper

Nevin E. Funk[27] opened the discussion of Mr. Clarke's paper by stating that one of the basic principles of power-plant design was that the simplest control consistent with best results should be obtained. This led him to criticize the use of two motor drives on the clinker crusher. He was convinced, from his own experience, that best results were obtained by continuous operation of the rolls, the speed varying with stoker speed. It was possible, he said, to eliminate the necessity of using water in the clinker-crusher pits. He said that the pits in the Colfax plant were too shallow to operate without water, and that the V-shaped sides acted as the buttress for an arch across which clinker would flux and hang unless cooled by water.

He asked if there might not be a possibility of error in the figures for the efficiencies of No. 8 boiler in September and No. 5 boiler in January and February. If such efficiencies could be maintained for a while, he asked, why not all the time with careful operation?

He spoke of the low superheat mentioned by the author and offered as an explanation the suggestion that in a low-set boiler secondary combustion might play a considerable part. With the advent of the more efficiently designed furnace, the heat available at the superheater, as well as the heat transfer rate, would be reduced, and more surface or a rearrangement of gas passages would be necessary to obtain the results expected.

B. N. Broido[28] said that the performance of the boilers at Colfax was of interest because of the large number of 1500- and 2000-hp. boilers now being installed or under consideration. The design of boilers had changed very little, he said, in the last few years, and it seemed that all efforts were being concentrated in the improvement of accessories. He discussed the subject of superheaters in considerable detail.

T. E. Keating[29] said that the paper showed what could be accomplished with modern high boilers and underfeed stokers without the aid of such heat reclaiming apparatus as economizers and air preheaters. He pointed out that the figures represented operating performance and should not be compared with a boiler test, in the common interpretation of the term. He discussed the combustible in the ash and the relation between mechanical and thermal conditions in stoker operation. He showed that time required for boilers to reach the point of maximum efficiency had

[22] Power and Mining Engrg. Dept., General Electric Co., Schenectady, N. Y.

[23] Power and Mining Engrg. Dept., General Electric Co., Schenectady, N. Y.

[24] Chief Engr. and Partner, Perin & Marshall, New York, N. Y. Mem. Am.Soc.M.E.

[25] Ohio Works, Carnegie Steel Co., Youngstown, Ohio. Assoc-Mem. Am. Soc. M. E.

[26] Professor of M.E., Carnegie Inst. of Tech., Pittsburgh, Pa. Mem. Am. Soc. M.E.

[27] Operating Engr., Philadelphia Elec. Co., Philadelphia, Pa. Mem. Am.Soc.M.E.

[28] Devel. Engr., Locomotive Superheater Co., New York, N. Y. Mem. Am.Soc.M.E.

[29] Gen. Mgr., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mem. Am.Soc.M.E.

been reduced from over seven to under two days, and the effect this had on average monthly efficiency.

D. Robert Yarnall[30] discussed the measurement of hot boiler feedwater, saying that his experience had showed him that the V-notch-weir method of measurement was extremely dependable, because it was accurate at low as well as at high rates of flow, because it compensated automatically for variations in temperature and because of the hydrometer action of the float which operates the recording mechanism.

The author replied to the discussion in part as follows: "In reference to the comments of Mr. Funk about the double drivers on clinker grinders, these grinders are about 30 feet wide, and at the time of designing them it was thought best to drive both sides. The clinker operation resulting from this design has justified the designers' ideas on that subject.

"As to the speed of the rolls, we never have been able to run the rolls slowly enough. Running the rolls even as slowly as four revolutions an hour is quite fast. The rate of speed of the clinker grinder depends entirely on the ash bed over it. If it is ground at too great a speed, the clinker grinder is burned out. We expected to make an improvement in the use of water in the pits. It has been found absolutely necessary to maintain flowing water in the pits to avoid losses in efficiency and other troubles due to clinkers.

"To touch again on the comparative efficiency of boilers No. 5 and No. 8, we have had an actual difference in this plant of over 10 per cent between adjacent boilers. When ferretted out, we find a certain type of ram, which is less efficient than another, and when we consider these high efficiencies we find many things to consider in stoker temperature. The boilers are not identical, neither are the efficiencies identical. In any boiler plant the size of this, two or three per cent difference in efficiency can be found in the boilers if operated at the ratings given. The man who is running a particular boiler has something to do with this difference. We have never found any of the meters on the boilers with an inaccuracy of over one per cent. The average difference in accurate value of the meters by actual test has been about 0.07 and never over 1 per cent.

"The superheat is low in the original boilers, due to heat absorption through the machine prior to the superheater.

"As to the lowering of oxygen in the barometric heater, we are trying some experiments of putting a slight vacuum on the barometric head, to see what can be done in the way of dilution which will remove the air, and also in heating the feed tank where most of the absorption takes place.

"At the time the plant was built coal was selling at $2.35 at Pittsburgh. We realized that the price of coal was going up, so that $3.50 was the rate assumed for a period of ten years. At that rate, and with the construction costs prevailing at that time, the economizers would begin to pay for themselves when coal reached $7.00 a ton.

"There were two questions regarding oxygen elimination. The oxygen elimination in that heat-balance system involves two factors, which are more accidental than otherwise. It is perfectly natural that there would be a lower value than the theoretical in a cycle in operation.

"Another feature is the time element which is necessary for absorption. We have no special means for oxygen elimination other than what occurs due to the heating, which drives out the oxygen. We are now trying some means of infiltration which will lower the heat further.

"In answer to Mr. Hutchins' comments on the maximum boiler rating, these boilers operate normally from 130 to 210 per cent of rating during the day of 24 hours. We have run them on test as high as 313 per cent for four or eight hours, but the average would be around 175 per cent.

"For February, March and April the total output of the plant was estimated at 97,575,100 kw-hr., and the load factor was 77.5 per cent. This station is operating on the base load as much as possible and the B.t.u. rate per kw-hr. average output, for the months of February, March and April, was 18,713.

"In answer to Mr. Trinks' comment as to air and coal control, some persons think that coal and air can be controlled automatically. It cannot be done. The air is controlled automatically, and the coal by hand.

[30] Yarnall-Waring Co., Philadelphia, Pa. Mem. Am.Soc.M.E.

"In answer to Mr. Bailey's comment regarding the overheating of the superheaters, in the new location it would be impossible to overheat the superheater by any change which did not bring about additional stresses over and above those of the cycle for which the superheater is planned, and if there was an element causing an increase in temperature it would cause overheating in the metal.

"As to Mr. Carter's question on the measurement of flue gases, we use mercurial pyrometers for these readings. We have tried others, but not with satisfactory results.

"In answer to Mr. Davis' question, the baffles are the standard B. & W. baffles, brick-backed, with cast-iron supports. We are going to try these baffles on some additional boilers. We use only the cast-iron baffles. We do not use any poured baffles."

SECOND GENERAL SESSION

At the Second General Session of the Spring Meeting, held on the morning of May 10, four papers were presented: Centrifugal Castings, by Leon Cammen; The Muscle Shoals Plant and the Nitrogen Supply, by Major J. K. Clement, presented by George A. Orrok; Heat Losses from Bare and Covered Wrought-Iron Pipe at Temperatures up to 800 Degrees Fahrenheit, by Russell H. Heilman, and the Evaporation of a Liquid into a Gas, by W. K. Lewis. Major Clement's paper appeared in the June issue of Mechanical Engineering. The papers by Mr. Heilman and Professor Lewis are published in this issue, while Mr. Cammen's paper will appear in an early number. W. S. Finlay, Jr., Manager of the Society, presided. A brief account of the discussion follows.

Discussion of Mr. Cammen's Paper

W. M. Corse wrote that engineers should be interested in centrifugal casting because commercially it was so practical. The speed of production far exceeded that of ordinary sand molding, he said, and the quality of the product was superior.

James B. Ladd[31] regretted that the author had not emphasized the extreme difficulty of making successfully castings by the centrifugal process. He felt that no engineer should undertake to develop the process without knowledge of these difficulties. It should be noted, he said, that a commercially perfected centrifugal process not only produced a product competitive in cost and quality with like products by other processes, but usually the centrifugal product was of superior quality.

Discussion of Major Clement's Paper

In the discussion which followed his presentation of Major Clement's paper, Mr. Orrok[32] said that his experience had shown that water-power plants would pay interest whenever the cost was less than $120 per kilowatt of machinery installed. He had known of plants costing as high as $500 per kilowatt. These plants had begun to pay interest only after the original investment had been written off, that is, after the original stockholders had lost their money. Since the increase in the price of coal, it was possible, he said, to pay as high as $200 per kilowatt and compete with steam plants, but $400 per kilowatt could not be invested with profit. Muscle Shoals, he said, was a very costly water-power development. At the present time no one could say what the cost of the plant would be, but it was his opinion that it would be in the neighborhood of $400 per kilowatt.

W. S. Finlay, Jr.,[33] chairman of the meeting, spoke of the necessity of keeping the Muscle Shoals plant so that it might be available in case of war.

Mr. Orrok said that the South was full of by-product industries, but he had heard no discussion of ammonium sulphate. Ammonium sulphate, he said, was pretty well known; it was produced regularly and at present commanded ready sale. Other nitrogenous compounds in the by-products from the distillation of coal, cyanides, are almost invariably thrown away. He did not have personal knowledge of one plant in which there was an attempt made to save the cyanides. An amount of cyanide is allowed to escape today in the United States equivalent to double

[31] Cons. Engr., Philadelphia, Pa. Mem. Am.Soc.M.E.
[32] Cons. Engr., New York, N. Y. Mem. Am.Soc.M.E.
[33] V. P., American Waterworks & Electric Co., New York, N. Y. Mem. Am.Soc.M.E.

the output of the Muscle Shoals plant in fixed nitrogen, but commercially it is not worth saving.

There is one other point of view that should be remembered in connection with the Muscle Shoals plant. That plant was designed three or four years ago. Today it is practically ancient history. The process has developed so much that if the plant were to be used it would have to be reconstructed. If the plant waits another four years it will probably have to be rebuilt entirely, and by 1930 fixed nitrogen will probably be made in a very differently designed plant.

Dr. Stumpf spoke of the plant built in Germany during the war for the manufacture of nitrogen products. Since the end of the war it had been reconverted in an astonishingly short period for the manufacture of fertilizers.

The discussion of Mr. Heilman's paper appears directly after his paper in this issue, page 437.

The paper on The Evaporation of a Liquid into a Gas was presented by title. Written discussion was presented for record in the Transactions of the Society.

MANAGEMENT SESSION

On Thursday morning, May 11, the Management Session was held under the auspices of the Management Division with L. P. Alford, Vice-President of the Society, in the chair.

After the Committee on Management Terminology, which is made up of representatives from the Society of Industrial Engineers, Industrial Relations Association of America, National Association of Cost Accountants, Taylor Society, American Institute of Accountants, and the Management Division, rendered its report, the two papers, Management Applied to Textile Plants, by George S. Harris, and The Southern Worker—His History and Character, by Frank H. Neely, were presented. The former was published in the June issue and the latter in the May issue of Mechanical Engineering.

Both papers were discussed together. J. A. McPherson[34] believed that a good part of the success of the southern mills was due to the close contact of the management with the employees, while in a written discussion, Charles H. Eames[35] predicted that the management of the textile mills of this country will continue to be more and more in the hands of broadly trained manufacturers who are essentially textile engineers. He termed managerial ability as an amalgamation of natural intelligence, educational training, personality and experience.

C. M. Bigelow[36] believed that the success of a mill was greatly dependent upon a properly maintained mechanical department, having an adequate storage of repair parts, mechanical supplies, etc., and a gang of repair men who could promptly handle emergency repairs, but whose overhead cost would be absorbed by continuous work along routine repairs, machining of repair parts, etc. Mr. Bigelow differed with the author and considered that too much emphasis is put on the technical ability of the department heads and not enough on their purely managerial responsibilities.

In a written discussion Frank B. Gilbreth[37] stressed the points that there is one best way for performing any operation and that the various conditions in the textile mills have not been properly studied in general in order to produce superintendents by which one best way may be discovered and put into effect.

In the last of four written discussions read by Prof. Eaton Webber of the Georgia School of Technology, E. A. Lucey[38] advocated a study of conditions and individual training of the workers by a specialist. Although this training is expensive, it pays for itself from the start and later dividends by establishing a better understanding between the management and the employees. Also after this instruction in the best way to do the work, the difference in the amount of work done between the poorest and the best workers should not be over 15 to 20 per cent.

[34] Ch. Engr., Plan and Construction Dept., J. E. Sirrine & Co., Greenville S. C. Mem. Am.Soc.M.E.

[35] Pres., Lowell Textile School, Lowell, Mass.

[36] Ch. Engr., Cooley & Marvin Co., Boston, Mass. Mem. Am.Soc.M.E.

[37] Pres., Frank B. Gilbreth, Inc., Montclair, N. J. Mem. Am.Soc.M.E.

[38] Pres., H. L. Gantt Corp., New York, N. Y. Mem. Am.Soc.M.E.

Frederick McDonald[39] called attention to the recently published book entitled Waste in Industry, which placed 50 to 80 per cent of the waste on management and charged the latter with responsibility for improvement. He also urged the training of the mental equipment of workers and a realization that management is not only the problem of the men at the head of the organization, but of every individual who directs some one under him as well.

C. H. Fish[40] pictured the transition during the past twenty years in the nationality of the labor in the northern cotton mills and the utter impossibility of treating the present-day conglomeration of nationalities and classes in the same way as the southern worker. Also since the northern mills were built first, the southern manufacturer has avoided their mistakes and shortcomings.

In the closures, Mr. Harris pointed out the need of standardization before the American manufacturer could compete in foreign markets and the wonderful opportunity before the Society to accomplish the task through its officers and committees. Mr. Neely was opposed to involving workers, who were usually of inferior mental capacity, in the responsibilities of management, but considered it very much better to develop the managerial control.

POWER SESSION

At the Power Session held on Thursday morning, May 11, D. W. Mead presiding, three papers were presented, namely: Economics of Water-Power Development, by C. A. Mees; Power Development in the Southeast, by Chas. G. Adsit, and Hydroelectric Power-Plant Design, by John A. Sirnit. Mr. Mees' paper appears in this issue. Mr. Adsit's paper was published in the May issue of Mechanical Engineering and Mr. Sirnit's paper will appear in an early number.

In a written discussion of Mr. Mees' paper L. A. Magraw[41] pointed out that steam-power plants could be developed in units as the demand grew while water-power plants are constructed complete in the beginning with the result that often heavy losses are sustained by the latter during the early period of operation when the load is considerably less than the capacity of the plant. Regulatory bodies have not given the proper consideration to these deficits and instead of determining the allowed revenue upon replacement cost, new, less depreciation, have attempted to determine the cost in prewar times plus the additions since that time. Then from this historical value of the property is deducted the accrued depreciation arrived at by comparing the physical condition of the plant at the time of the rate inquiry with a similar plant new. This is simply an arbitrary way of reducing the value of the property for rate-making purposes and has no relation to the market and economic conditions in the territory, which should fix the rates.

A. A. McLeod[42] in referring to written instructions for employees, said in his experience that the way to get the best service is to aid the employee in every possible way to discover the fact that he has a brain and then he will use it.

Geo. A. Orrok[43] considered it unfortunate that Mr. Mees adheres to the idea of primary and secondary power. Primary power cannot be sold or used as no one today has a 100 per cent load factor. Those having to do with pulp making or metallurgical projects may have an 85 or 87 per cent load factor, but most plants must be content with a 50 per cent load factor and this is not primary power or even secondary power. Mr. Orrok stated that kilowatt-hours and not kilowatt-years are the units of sale of power.

Chairman Mead emphasized the importance of the economic advisability and justification of any water-power project. These must be established before the project is built.

In closing Mr. Mees called attention to the value of written instructions not only to employees but also to the person preparing the instructions. He decried the use of any other unit but the kilowatt hour for the sale of power, but he reiterated the fact that

[39] Mgr., D. McDonald & Co., Albany, N. Y. Mem. Am.Soc.M.E.

[40] Cons. Engr., Boston, Mass. Mem. Am.Soc.M.E.

[41] Genl. Mgr. and Treas., Central Georgia Power Co., Macon, Ga. Mem. Am.Soc.M.E.

[42] Engrg. Supt., Florida Phosphate Min. Corp., Bartow, Fla. Mem. Am.Soc.M.E.

[43] Cons. Engr., New York, N. Y. Mem. Am.Soc.M.E.

there are two classes of power: one that must be available at any and all times, and the other in which there is some latitude in delivery.

Hydroelectric Power Development

In connection with the presentation of his paper, Chas. G. Adsit showed some airplane views of the water-power development and a moving picture of a portion of the construction of the Burton Dam. This is a cyclopean dam with gravity section, 1220 ft. long and about 125 ft. high. Its reservoir has a shore line of about 63 miles and contains 5,500,000,000 cu. ft. of water. This water now falls 608 ft. and delivers about 55,000,000 kw-hr. but will eventually fall 1220 ft. Another reservoir with a 24 mile shore line contains 1,400,000,000 cu. ft. and on present development has 15,000,000 kw-hr. capacity. The Tallulah Falls diversion dam is 360 ft. long and 116 ft. high and is built on a radius of 900 ft. A tunnel, 12 by 14 ft., runs a mile and a half through a mountain with a fall of 12 ft. and ends in penstocks that drop to the Tallulah Falls plant of 108,000 hp. capacity. A new development under construction at Tugelo will have a dam 150 ft. high and in the plant will be four 20,000-hp. turbines and four 12,500-kw. generators.

In the discussion which followed Oscar G. Thurlow[44] pointed out the valuable location of the Muscle Shoals hydroelectric power project for serving a region which, compared with other sections of the Southeast, has suffered in its industrial development because of lack of power. There is a market now available for the disposal of the primary power and a chemical plant to use a great part of the secondary power, so that with a general distribution of the Muscle Shoals power an industrial advance in this region would naturally follow.

F. P. Cummings[45] gave the details of the emergency in 1921 which the power companies of Tennessee, Georgia and the Carolinas were only able to meet through the interconnecting of the systems, and finally how the leasing for one year of the 60,000-kw. Government power plant at Sheffield, Ala. has insured power service to many industries that might otherwise have been compelled to curtail their production during the low-water period, and provided power services for industrial expansion in this territory.

Prof. C. S. Brown[46] decried the power that was being lost every day at Muscle Shoals because of its incomplete development and Mr. Orrok commented on the mean flow of the Tennessee River and the total fall of water available there.

Mr. Adsit, in his closure, reiterated the statement in his paper that Muscle Shoals is good for about 100,000 hp. in primary power and an undeterminable amount of secondary power, and said that the minimum flow of the Tennessee River is probably around 5500 second-feet.

The last paper of the session was given by Mr. Sirnit, who described his subject as an improvement in the design of an hydroelectric power plant which will not only give more kilowatts but kilowatt-hours without any additional cost. By ingenious application of the kinetic energy of the water, action similar to an ejector is obtained, and the normal tail water is raised at the same time the head on the machine is increased. The details of tests of models of the Thurlow suppressor then followed and in conclusion a description of the development now under construction incorporating the idea.

Mr. Adsit commended this new application of the idea and believed that engineers would eagerly await the operation of the plant.

SYMPOSIUM ON WELDING

THIS symposium was arranged under the joint auspices of the A.S.M.E. Boiler Code Committee and the American Welding Society to supplement the public hearing on the proposed code for unfired pressure vessels held at the Annual Meeting last December. Four papers were selected for presentation. These papers were: Strength of Electrically Welded Pressure Containers, by R. J. Roark; Some Principles of the Construction of Unfired Pressure Vessels, by S. W. Miller; Steel for Forge Welding, by F. N. Speller; and Tests on Welded Cylinders, by E. A. Fessenden and E. J. Bradford. The dire need of a code was indicated by the numerous communications, acknowledging meeting announcements sent to interested manufacturers and individuals, which urged action. Mr. Roark's paper was published in the April issue, and Mr. Miller's in the June issue; Mr. Speller's is printed in this issue of Mechanical Engineering and the fourth will appear in a later number.

Edward R. Fish, who presided at the session, is Chairman of the A.S.M.E. Boiler Code Sub-Committee on Air Tanks and Pressure Vessels. In his opening remarks he reviewed the status of welding pressure vessels.

The discussion at this session was of such general interest and so much new material was submitted that a more complete treatment of the discussion will be presented in the August issue of Mechanical Engineering than is customary with meeting discussions.

[44] Ch. Engr., Alabama Power Co., Birmingham Ala. Mem. Am.Soc.M.E.

[45] Operating Supt., Alabama Power Co., Birmingham Ala. Mem. Am.Soc.M.E.

[46] Professor of M.E., Vanderbilt University, Nashville, Tenn. Mem. Am.Soc.M.E.

Stainless Steel

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C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions

The Engineer and World Problems

America and the Rehabilitation of Europe was the general topic of the twenty-sixth Annual Meeting of the American Academy of Political and Social Science held in Philadelphia May 12 and 13. For the six sessions, various aspects were discussed under the subtopics: The Industrial and Financial Situation in Europe and Its Remedies; To What Extent is America's Prosperity Dependent on the Rehabilitation of Europe; America and the Debts of Europe; America and the Political Situation in Europe; Is America's Coöperation Indispensable to European Rehabilitation; America's Relation to the European Situation.

Alfred D. Flinn

Men and women from Europe and many parts of America were the speakers and treated the subjects from first-hand knowledge. Large audiences of thoughtful persons listened intently to all the papers and discussions.

Diplomats, business men, bankers, statisticians, representatives of Labor and the press, men experienced in governmental service, a manufacturer and an engineer, alike, presented, in the main, the economic and political phases of the topic. Russia and the Genoa Conference received much attention, as well as payment of international debts, upbuilding of mutual confidence among peoples, and stabilization of industrial, political and financial conditions.

In a broad way, all the papers were of interest to engineers. With one notable exception, however, the speakers referred but incidentally to the parts of the engineer, the scientist and the educator in the solution of present-day world problems. In the main, the speakers dealt with the mechanisms of industry, trade and government to the exclusion of fundamental principles, such principles as were dealt with being, for the most part, the rules of trade. Only by scant implication was there recognition of the mighty mental forces newly developing the world's resources, both physical and intellectual, through science and technology, or of man's increasing endeavors to know and use more effectively both his mental and physical capacities. Counting-room, rather than laboratory, supplied the tests for acceptability of proposed solutions of the world's problems.

The notable exception to which reference was just made, was the address of Dr. B. Stepanek, Minister at Washington of the Czecho-slovak Republic. He appealed for the establishment in Central Europe of a great American university and library as a center from which could be given out the best products of American culture, a source of correct information about America and of the best American ideas. He pleaded, also, for some influential alliance of the engineers of all countries—a World Federation of Engineers—through which this constructive type of mind could be brought more effectively into the service of the nations. He suggested that at an early date, there should be an international conference of such men, rather than of politicians and of statesmen, bound by tradition and self-seeking nationalism—a conference of constructively-minded men who could take fresh views of the world's condition, deal scientifically with fundamental causes, and suggest impartial, far-sighted plans for continuing progress.

But the politician yet holds the reins of government. Will he give the engineer a chance to contribute in any large measure to the direction of national and international affairs? What can the engineer do by way of preliminary demonstration of his capacity to deal with problems which need the engineer's loyalty to facts, power to analyze, and enthusiasm for construction, but which are not amenable to slide rules and instruments of precision? It is certainly noteworthy that a man, trained to diplomacy from his youth and who has devoted his life to that calling, should so insistently urge participation of the engineer in present-day problems of state. Is he not right, for have not the engineers and scientists, by their wonderful advancement of physical and intellectual development of the world, brought about social and industrial conditions with which statesmen and politicians are not yet prepared to deal?

How can Dr. Stepanek's remarkable suggestion, repeated on several occasions, be put into effect? Why not a "trial trip," in the parlance of the marine engineer, a joint convention of the great national American societies of engineers in Europe in the summer of 1923, to meet engineers of all the countries of Europe for discussion of such of the world problems as may be most vulnerable to engineering attack?

The meetings of the Academy were important and cannot fail to have widespread effect upon public opinion in the course of time. In the future, engineers should have places on the program and do their share in studying such subjects as the Academy selects for its meetings.

Alfred D. Flinn.[1]

Coöperation in Standardization—An Opportunity for Engineers

As a direct result of the report of the F.A.E.S. Committee on Elimination of Waste, Secretary Hoover instituted a countrywide program of simplification in sizes and varieties of commodities in general use, such as paving brick, axeheads, shot-gun loads, etc. To carry out this work properly, he established the Division of Simplified Practice in the Department of Commerce and placed at its head W. A. Durgin, formerly of the Commonwealth Edison Company of Chicago.

The American Engineering Standards Committee was organized in 1918 by the national engineering societies for the purpose of coördinating the standardization activities of the various engineering groups and industrial associations of this country. It also furnishes a valuable contact with the standardization work of foreign countries. This Committee has now developed into an organization with one hundred and sixty coöperating bodies and has established a noteworthy plan of procedure that provides for the absolute autonomy of the member bodies in standardization work. The success of the Committee's plan of procedure is fully demonstrated by the rapid increase in number of member bodies and by the fact that, to date, twenty standards have been approved and fifty standardization projects are in process.

To insure coöperation between these two organizations having

[1] Mr. Flinn, Secretary of the United Engineering Society, was appointed Honorary Vice-president to represent the A.S.M.E. at the Twenty-sixth Annual Meeting of the American Academy of Political and Social Science.

similar objects but different fields, as will be explained later, Mr. Durgin has been appointed a member of the American Engineering Standards Committee and A. A. Stevenson, a former chairman of the American Engineering Standards Committee, has been appointed as a member of an Advisory Committee to the Division of Simplified Practice.

The American Society of Mechanical Engineers is coöperating with the American Engineering Standards Committee through its delegation of three representatives. E. C. Peck, Chairman of this delegation, is also Chairman of the A.S.M.E. Standing Committee on Standardization.

It is obvious, that to carry out an economical program of standardization, there must not be duplication on the part of this new activity of the Department of Commerce with the established American Engineering Standards Committee. It is well recognized that in the field of standardization the American Engineering Standards Committee is the logical body. This field embraces all projects which are of special interest to engineering and associated industries. The Division of Simplified Practice agrees not to enter this field. It desires to develop, however, a field of broad usefulness by reducing the number of sizes and by simplifying the varieties of manufactured articles in common use.

On May 4, Secretary Hoover invited the American Engineering Standards Committee to solicit the coöperation of its member bodies in a canvass to determine what simplification of manufactured products is most needed and most desired at this time. On May 22, the American Engineering Standards Committee unanimously accepted this invitation and voted to urge the immediate and active coöperation of the member bodies in carrying on this canvass. In accord with this action of the American Engineering Standards Committee, the Standardization Committee of the American Society of Mechanical Engineers met on June 13 jointly with some of the Society's members who served on the Waste Committee. This joint body recommended to the Council of the Society that immediate steps be taken to secure the suggestions desired by Secretary Hoover from the membership of the American Society of Mechanical Engineers. To this end the Society's membership has been addressed through the eleven Professional Divisions. Prompt replies have been requested as it is desired to place the suggestions of the membership in the hands of the Department of Commerce as soon as possible. Publicity has also been given in the June 22 issue of the *A.S.M.E. News*.

Every reader of Mechanical Engineering should realize his personal obligation to use his knowledge and experience in securing suggestions of manufactured products that will permit of simplification or standardization. This request of Secretary Hoover should be an incentive to the engineering profession to contribute a service it is eminently fitted to render. Give thought to the common manufactured articles that you touch and see daily and consider the possibilities of simplification or standardization. Send in the results of your study at once and you will have assisted materially in this sincere effort of the Secretary of Commerce to reduce in some measure the present wastes in industry.

Science for the Layman

As the life of the engineer is spent in applying the principles of science to the improvement of our condition, he should, above all others, be interested in the wide dissemination of accurate information concerning science among laymen, and should therefore give a hearty welcome to the recently published "Outline of Science." Here is a popular account of the essentials of present-day science, long enough to cover the outline, yet not long enough to be tiresome, eminently readable without attempting to be sensational, and amply and intelligently illustrated. The work is edited by J. Arthur Thomson, regius professor of natural history in the University of Aberdeen, whose standing vouches for the accuracy of the text.

After the flood of books of "popular" science that has recently emanated from so many unskilled pens, it is a pleasure to call attention to one that reports the latest opinions of authority, in a form suitable for young and old alike.

Harrison W. Craver.

Making a Start in Government Reorganization*

The continuance of great Government expenditures has shown the impossibility of cutting appropriations and payrolls to any great extent except by substituting sound business methods for wasteful and extravagant procedure. The first step needed in effecting this improvement must be to make thorough reorganizations, grouping under distinct departments those functions or activities which are of similar character or should logically be coördinated.

The business administrative methods of the Federal Government have no satisfactory provision for planning a department. Each bureau covers as much ground as is permitted by its construction of the authority received by it. The result is that many bureaus duplicate the work of others by doing much the same type of work. For instance, in the engineering and construction work of the Federal Government there are twenty-seven different agencies engaged in building construction, sixteen in road construction, nineteen in hydraulic construction, twenty-two in engineering research, twenty-five in surveying and mapping, six in coast fleets, sixteen in work on rivers, ten in public-land functions, and fifteen in chemical investigations.

Obviously there is need of a controlling agency to allocate specific work to each bureau, make it operate within prescribed limits and insure that its work supplements that of the others. This state of affairs is typical of conditions existing in other Government activities.

Engineers in touch with Government business methods and knowing the waste resulting from present practice, have for many years discussed plans for bringing together into one existing Department, all the commonly known Public Works. As a result, delegates from seventy-four engineering, technical, and business societies, with a combined membership of over one hundred thousand met at Chicago in April, 1919, and founded the National Public Works Department Association. Its object was to establish in the Federal Government a systematic, businesslike organization to carry out public works, similar to that in use by private concerns and by practically all other important nations.

The Association, whose task has been taken over by the American Engineering Council of the Federated American Engineering Societies, proposed no radical reorganization, additional Government Department or Cabinet officer. It advocated that the Department of the Interior be changed into the Department of Public Works, that bureaus in other Departments engaged in public works be transferred to this Department, and that Interior Department bureaus not so engaged be placed elsewhere.

The adoption of such a plan is essential to the success of a budget system in national works. It would reduce taxes by cutting down overlapping activities, and minimizing the duplication of work. The proposal serves the interest of no class, has no politics and is absolutely non-partisan.

A bill known as the Jones-Reavis Bill, providing for these changes, has been introduced in Congress and is securing general support.

Howard Monroe Raymond Heads Armour Tech.

On May 23, 1922, the Board of Trustees of Armour Institute of Technology announced the appointment of Dr. Howard Monroe Raymond as President of that institution. Dr. Raymond has served as Acting President of the Institute since the death of Dr. Frank W. Gunsaulus last year, and has also been Dean of Engineering since 1903.

President Raymond is well known in the educational and engineering world through his activities at the Institute during the past twenty-seven years. He is a graduate of the University of Michigan and a member of leading engineering and scientific societies.

His appointment to the presidency of this rapidly developing engineering college assures to its students and alumni a continuation of progressive plans for the future of the institution.

* Extracts from a Statement by Francis Blossom, Chairman during the War of the Board of Review of Construction of the War Department, and Representative on the American Engineering Council of The American Society of Mechanical Engineers.

Ambassador Jusserand and Secretary Hoover Attend Engineers' Dinner

IN furtherance of its desire to cultivate camaraderie between French and American engineers, the American Section of the Société des Ingénieurs Civils de France entertained at dinner on May 29 the members of the deputation of American engineers who carried the John Fritz Medal last year to Eugene Schneider.

The dinner was given at the University Club in Washington. Herbert Hoover, Honorary President of the American Section of the Société, presided. The guests included, Ambassador Jusserand of France and the presidents and secretaries of the four Founder Societies, the United Engineering Society, the Federated American Engineering Societies, the Engineering Foundation, and the John Fritz Medal Board of Award. Dean Dexter S. Kimball, President of the American Society of Mechanical Engineers, was represented by Leon P. Alford. Regrets were received from Dr. Ira N. Hollis, Robert A. Cummings, F. L. Hutchinson, Dr. Wm. McClellan, and Dr. F. B. Jewett.

In speaking of the work of engineers, Ambassador Jusserand pointed out a marked difference between American and French engineers. The former have at their command colossal natural resources, the latter but limited resources. This has tended to make Americans careless. "They rush into their work with full steam on," he said. "All is hustle and bustle; they want results regardless of effort or expense; they waste their resources in reaching their ends. The French engineer is careful and cautious; each step is carefully calculated; there is nothing to waste, and hence nothing is wasted. And I believe," he added, "that in the end neither has much the advantage." "I think it is shameful the way you treat your locomotives. You build them strong and powerful; you put any driver into them and he runs his engine simply as a powerful machine to get results, and when the results are secured, the engine goes to the scrap heap. Our engines are built like a watch. They are cared for as a race horse, each by its own driver who is as careful of it as of any live thing, and who regards it as his child to be watched and cared for and tended through a life that may continue for many years."

"It is a mistake for us to send our young men just out of college to get their early practice training in this country. Your conditions are so different from ours; so it would be a mistake to send your young men to us. But after each has had training in his own country long enough to become acquainted with local conditions, then the study abroad is most valuable, in order that each may have the opportunity of learning those things which may be adapted to his own home conditions."

Aimé Dumaine, President of the American Section of the Société, then read several cables from France, among them one from the President, felicitating the Section on its happy idea of holding this joint meeting, and another from Marshal Foch, the only member of all societies represented, congratulating the Societies on this occasion, which he hoped would be the forerunner of many more similar gatherings.

M. Dumaine spoke of the friendship and respect which had grown up during the war between the engineers of the two countries. "Nothing must come to destroy this," he said, "and by our united action we can not only preserve it, but we can develop the same feeling between other professions and between the people at large.

"Ambassador Jusserand has been working for twenty years to establish and maintain an international good will which engineers now feel, and this may be made permanent through the International Organization of Engineers which we hope to form."

Mr. Hoover spoke of the criticisms which the people of each nation directed toward the other during normal times. "Do not take these criticisms too seriously," he said. "Some of them may have point, most of them have not; but I venture to say that in time of stress, if it ever comes again, we shall be found marching shoulder to shoulder with the same righteous end in view."

Ambrose Swasey, speaking for the members of the deputation, recited the many instances of hospitality shown its members when abroad. He said in part, "I trust that the American Section of the French Société will grow in numbers and influence. I trust that the French Sections of the American Societies will do the same, all to the end that there shall be just one great society, making for the peace of the world. We are handicapped by our ignorance of your language, but this is a small difference; while our tongues may not synchronize, our hearts are in perfect attune."

John R. Freeman, President of the American Society of Civil Engineers, pointed out to what great extent American engineers were indebted to the early French engineers for the mathematical formulas still in use, for our knowledge of hydraulic engineering, for city planning, and recently for the development of reinforced concrete construction.

J. Vipond Davies, President of the United Engineering Society, then offered the use of the Engineering Societies' Building in New York to the American Section of the Société for such purposes as it might require, and President Dumaine gratefully accepted this mark of courtesy.

Mr. Hoover, in bringing the dinner to a close, suggested that the most useful and constructive thing that could be done at this time was to bring into association men of similar callings. "In our association of engineers," he said, "there are no secrets. Their experiences, their skill and their inventions are freely interchanged and form a common bond. United they should and will form an irresistible force for the peace of the world, either by moral suasion or by making war too terrible to contemplate. Individually, or as relatively small units, we are impotent; by association only can the work be done. An international organization is not only possible, but it is practicable. We know that the French engineers have a hearty welcome here; we know that we are welcome over there, and when this new organization is formed, there will be no 'Article 10.'

The Longstreth Medal Awards

The Edward Longstreth Medal, awarded by the Franklin Institute for inventions of high order and for particularly meritorious improvements and developments in machines and mechanical processes, was presented to Joseph F. Keller of Brooklyn, N. Y., and Samuel T. Freas of Trenton, N. J., in the Hall of the Franklin Institute in Philadelphia on April 19, 1922. The Medals and accompanying Certificates are presented to "gentlemen whose inventions have been examined by the Committee on Science and the Arts and found worthy of recognition by the Institute."

The award was made to Mr. Keller for his invention of the Keller

THE EDWARD LONGSTRETH MEDAL

automatic die-cutting machines. These machines were described by their inventor in a paper he presented at the Annual Meeting of The American Society of Mechanical Engineers, of which he is a member, in December, 1920. The Institute believed that credit should be given to Mr. Keller for having met a recognized need for increasing die production and reproduction by methods which have resulted in easier, quicker and better production by less skillful operators and a reduction of the costs. Mr. Keller's invention which consists of a cutting tool with a tracer following a pattern, successfully overcomes the difficult problem of retaining sensitiveness with ability to do heavy cutting.

Mr. Freas received the award for his invention of the "interlocking" tooth saw. The outstanding feature of this device is an unusual but very simple combination of wedges which holds the teeth firmly in place in spite of the intense stresses set up when doing heavy work. The excellence of his design has resulted in the extended and successful commercial use of the saw.

Presentation was made by Dr. Walton Clark, President of the Franklin Institute.

The *Majestic*, World's Largest Liner, Makes Its First Visit to New York

THE White Star liner *Majestic* docked in New York for the first time in May. Not only is she the largest liner afloat, but she will very likely continue to have this distinctive position for some time to come. The *Majestic* is the result of the prewar competition for size and speed in Transatlantic liners, and with the altered economic conditions and present high constructional costs, her equal will probably not be built for some time. Interest in the *Majestic* was doubtless increased by the fact that her sister ship, the *Leviathan*, (formerly the *Vaterland*) had recently been sent to Newport News to be refitted for Transatlantic traffic.

Originally built to the order of the Hamburg-Amerika Line at the Elbe shipyard of Blohm and Voss, Hamburg, and christened the *Bismarck*, work on her was well in hand when the outbreak of war came, and was continued till about the middle of 1916. After that time little progress was made, and about that period all copper pipes were removed and replaced by pipes of steel, which have for the most part been retained.

By the Versailles Treaty it was provided that vessels under construction should be completed by the Germans as designed and handed over to the Reparations Commission. The *Bismarck* was one of some twenty-five ships allotted to Great Britain, representing a gross tonnage of 225,000 tons. The White Star Line purchased the *Bismarck* from the Reparation Commission, and renaming her the *Majestic*, began nearly a year ago to supervise her completion.

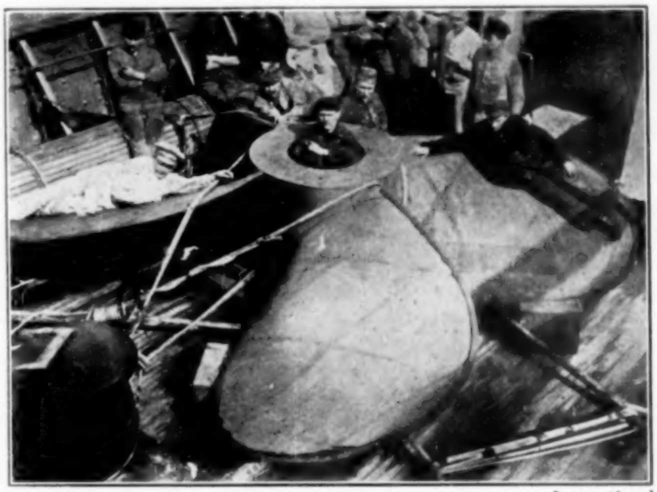
The Majestic has an overall length of 956 ft., and is 100 ft. broad, with a gross tonnage of over 56,000 tons, and a displacement of 64,000 tons when loaded to her marks. Her height from keel to boat deck is 102 ft., and the look-out man in the crow's nest is perched 180 ft. above the water line. A special feature in the design of the *Majestic* is the arrangement of her decks. Above the five steel decks, which run from end to end of the ship, there are four steel-plated erection decks which cover at least half her length. The boiler casings, instead of passing up the centre of the vessel, are divided and placed towards the sides of the ship, and are then carried up above the top deck, where they unite to form a center superstructure for the funnels. This method, which is adopted for two of the funnels—the third being a dummy funnel—

FIG. 1 THE WHITE STAR LINER *Majestic*

permits of better ventilation for the boiler rooms, and from an architectural point of view admits of great breadth in the disposition and size of the cabins and public rooms throughout the seven decks on which most of the first-class passenger accommodation is provided.

The full complement of the *Majestic* is over 5000 persons, this number including 850 first-class passengers, 545 second-class passengers, and 2392 third-class passengers, with a crew of over 1100.

The *Majestic* is driven by four-bladed propellers, each with a one-piece boss, made by the Manganese Bronze Company, Ltd., of London. Fig. 2 shows one of the spares. The propelling machinery consists of quadruple turbines of the combined-impulse and reaction type, Curtis wheels being fitted before the Parsons drums. The turbines are arranged in two engine rooms on the port and starboard. The steam enters the high-pressure turbine on the port inner shaft, and passes on to the intermediate-pressure turbine on the starboard inner shaft, from where, equally divided, it again passes to the two low-pressure turbines on the outer shafts. Each separate shaft, however, is available for running or manoeuvering by itself, but under ordinary working conditions the two low-pressure turbines operate in parallel. The total ahead horsepower is 66,000, and the astern power 36,000. According to contract, the vessel should travel at a speed of 23 knots when loaded to a mean draght corresponding to a departure draft of 35 ft. 6 in., and when the turbines are developing 66,000 shaft horsepower at a speed of 180 r.p.m., with a boiler pressure of 235 lb. per sq. in. On her run from Cuxhaven to Southampton she actually developed over 70,000 hp. and a speed of 25 knots was reached. The astern turbines are subdivided into high-pressure and low-pressure tur-



International

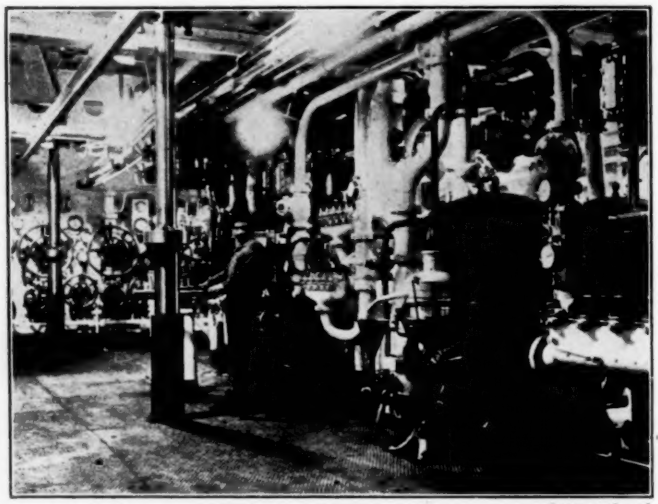
FIG. 2 ONE OF THE SPARE PROPELLERS

bines, and the low-pressure turbines are again placed on the outer shafts. By-pass valves are provided whereby high-pressure steam may be supplied to the other turbines, should at any time excess steam warrant this procedure. Thrust blocks of the ordinary pattern are provided. The turbines exhaust into pear-shaped condensers, and Weir's dual air pumps are installed. The turbine controls are all worked from a special control station (Fig. 3) placed above the engine rooms, and all the main valves are hydraulically operated and electrically controlled. The boiler installation consists of 48 water-tube boilers of the Yarrow-Normand type, which are fitted with oil burners working on the White low-pressure system. The boilers, accommodated in four boiler rooms, are designed for a working pressure of 250 lb. per sq. in. The combined heating surface is over 219,000 sq. ft., and the total grate area exceeds 4000 sq. ft. The boilers are fitted throughout with Mumford's patent automatic feed controls. Aft of the main engine room is an outer engine room, containing 5 A.E.G. turbo-generating sets, each having an output of 280 kw. A large central switchboard is provided, from which the lighting and power requirements of the ship may be controlled. Current is supplied to over 15,000 electric lamps, in addition to various motors. On E deck there is a special 70-kw. emergency dynamo, driven by an A.E.G. two-stroke cycle opposed-piston type engine of the Diesel type, with two vertical cylinders, which, along with its generator, is completely enclosed. The emergency set supplies current for the lighting and wireless installations, and also provides power for the six 20-hp. motors which operate the Welin boat-handling gear.

The system of telegraphs and telephones installed throughout the ship is very complete. Among the former may be mentioned the engine telegraphs, the starting telegraphs and rudder telltale, also the docking and anchor telegraphs, the boiler-room telegraphs and the distant revolution telegraph. A loud-speaking telephone system is installed for operating the ship and for communication

between the engine and boiler rooms, and this system is so arranged that any boiler room can speak to any other boiler room or to the engine rooms and the engineers' department. Communication between the look-out man in the crow's nest and the bridge is established by a loud-speaking telephone in addition to the ordinary telephone. The ordinary telephone system for executive and departmental use has its own central exchange, which may be connected to shore when the vessel is berthed.

There are three wireless stations, and the largest is capable of maintaining permanent connection with both continents during the whole of the voyage. A smaller station is used for communication over a distance of 800 miles, and a subsidiary one is reserved for use in case of an emergency. In addition to the usual signalling arrangements, special provision has been made to guarantee as far as possible the safe navigation of the vessel in fog. Submarine



International

FIG. 3 TURBINE CONTROL STATION

signalling gear has been installed, and the Willett Bruce electric fog bell and whistle fitted. The fire-alarm system includes some 450 fire alarms, distributed throughout the ship, which automatically indicate to the officer on watch when the temperature in any compartment has been exceeded. This system is centralized on the navigation bridge, and is combined with a smoke-detection device, consisting of lines of tubing through which air may be drawn. Other signals which are shown on the navigating bridge are the water-tight door indicators and the cooling-room door telltales. Electric clocks are fitted throughout the vessel. Every precaution has been taken to reduce as far as humanly possible dangers which might arise in case of fire or collision, and an ample complement of lifeboats is carried, including two motor lifeboats fitted with wireless. All boats are swung out and lowered on the Welin system, which, as previously mentioned, is electrically operated. A somewhat novel fitting is the Fram night lifebuoy, which may be instantly released from the bridge by electrical means. Fram anti-rolling tanks are also fitted in addition to the usual bilge keels. (Description of the *Majestic* taken from *The Engineer*, vol. 133, no. 3463, May 12, 1922, pp. 522–523.)

William Gleason, of Rochester, Dead

William Gleason, president and founder of the Gleason Works in Rochester, N. Y., died at his home on May 24, 1922, in his 87th year. He was born in Tipperary County, Ireland, and came to this country at the age of 15. He went to work in the machine shop of Asa R. Swift in Rochester, serving his apprenticeship there and in the shop of I. Angell & Sons. During the Civil War he was a workman in the Colt Armory in Hartford, Conn. In 1865 Mr. Gleason returned to Rochester and formed the nucleus of the Gleason Works. For a few years he was in partnership with John Connell and James S. Graham, but this partnership was dissolved in 1873. It was just at this time that he perfected the first practical bevel-gear planer which revolutionized the bevel-gear-cutting machine industry, and Mr. Gleason went with the Kidd Iron Works as superintendent. Two years later he took over the business.

Expansion of the business necessitated a larger plant in 1896. In 1910 there was a further enlargement, and the business has extended not only all over the United States but to foreign fields as well. Beginning with six employees in a one-room plant, the Gleason Works now covers more than twenty-five acres and employs 800 men. During the War the plant employed 1700 men in making ordnance supplies for the Government, and expanded its production capacity to three times its prewar capacity.

William Gleason piloted his firm through many dangerous business periods. His interest was always primarily with his employees and customers, and oftentimes he lost sight of cost and profit in an endeavor to turn out high-grade tools. He kept his standards high, and it was this integrity which brought him through periods which sometimes wrecked his competitors. At the fiftieth anniversary of the founding of the plant, old employees bore witness to his fairness and honesty.

Up until the latter part of 1920 Mr. Gleason took an active part in the management of the firm. He leaves to carry on his work two sons and Kate Gleason, his daughter, who is one of the three women members of the Society. Mr. Gleason became a member of the A.S.M.E. in 1897. He was a member of the Automobile Club of Rochester and of the Oak Hill Country Club.

Death of Henry M. Howe

Henry Marion Howe, dean of scientists in the domain of iron and steel, died on Sunday, May 14, 1922, at his home in Bedford, N. Y. Dr. Howe was born in Boston, Mass., March 2, 1848, and was the son of Dr. Samuel G. and Julia Ward Howe, both of whom were prominent in public activities. He received his A.B. from Harvard in 1869, his B.S. from the Massachusetts Institute of Technology in 1871 and his A.M. from Harvard in 1872. He received a number of honorary degrees, including an LL.D. from Harvard.

With the exception of approximately five years devoted to the metallurgy of copper, Dr. Howe's entire professional life was given up to the development of the iron and steel industry. He had an extraordinary facility in writing, and a power and tact in presiding over public meetings. Combined with an unusual keenness of observation and a devotion to the search for truth, he possessed the faculties which enabled him not only to make discoveries of his own, but to correlate and interpret the investigations of others and to clothe his data in a language so concise and simple that the ordinary mind could comprehend. The results of his labors are accessible to all in a number of books, several of which have been translated into French and Russian, and in many articles in encyclopedias and technical journals. His works give him the rank of the world's greatest authority on the metallurgy of steel.

Dr. Howe was famous as an expert in litigation on iron and steel. At the time of his death he was professor emeritus at Columbia University, where he had been professor of metallurgy from 1897 to 1913. During the World War and for some years subsequently, he served as Chairman of the Engineering Division of the National Research Council. He was a Past-President of the American Institute of Mining and Metallurgical Engineers, the American Society for Testing Materials, the International Association for Testing Materials, the Jury of Awards, Mining and Metallurgy, Chicago Exposition, etc.

In January of 1917 Dr. Howe was awarded the John Fritz Medal for his "investigations in metallurgy, especially in the metallography of iron and steel." Dr. Howe was the thirteenth to receive this signal honor since its first award in 1902 to John Fritz. The Medal is awarded for notable scientific or industrial achievement by a Board of Sixteen appointed in equal numbers from the members of the four national societies; American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

Honors had been conferred upon him by scientific societies not only of our own country but of many of the steel-producing nations of the world. He was an honorary member of the American Iron and Steel Institute and had received the Bessemer Medal of the Iron and Steel Institute of Great Britain.

Engineering and Industrial Standardization

Standards in the Making

Gears. Reprints of the five standards published in the May issue of MECHANICAL ENGINEERING were presented to the American Gear Manufacturers' Association during its recent meeting in Buffalo. The Society of Automotive Engineers and the American Society for Testing Materials have also distributed copies of these reprints to their interested committees. The Sectional Committee on Gears is now awaiting comments. *Chairman,* B. F. Waterman; *Secretary,* J. P. Kottcamp.

Shafting. With the standards for transmission and machinery shafting diameters and their tolerances out of the way, this Sectional Committee is now turning its attention to key sizes and tolerance and also to the development of a standard method for determining the size of shaft necessary to transmit a given load.

The Sub-Committee which is working on this latter problem has completed the first third of its work which covers the various stress conditions that may be set up in a transmission shaft; the various theories, evolved from time to time, leading to the many formulas found in engineering literature; the application and limitation of the various theories of elastic failure as applied to ductile ferrous material used in shafts. *Chairman,* C. M. Chapman; *Secretary,* C. B. LePage.

Machine-Screw Threads. The Sectional Committee on the Standardization and Unification of Screw Threads is now reviewing the revised report of its Working Committee. An open meeting will be held in the near future at which this report will be passed on finally and the report of the Sub-Committee on Gages and Gaging Methods will be presented for discussion. *Chairman,* L. D. Burlingame; *Secretary,* C. B. LePage.

Ball Bearings. Following the return of Mr. O. R. Wikander from his visit to France and Germany where he conferred with standards authorities of these countries, and also those of Sweden, a series of meetings of the Sectional Committee was held in New York. At these meetings counter proposals to those made by the Germans and the Swedes were drafted and sent abroad. These proposals concern the standards for the widths and depths of radial bearings.

A Sub-Committee of the Ball and Roller Bearings Division of the Society of Automotive Engineers, one of the sponsor bodies, is at work on the standardization of thrust bearings. It is working on the O. D., I. D. and distance between faces of single- and double-direction flat-face and self-aligning bearings. *Chairman,* W. R. Strickland; *Secretary,* R. S. Burnett.

Pipe Flanges and Fittings. This large Sectional Committee is making excellent progress in the work assigned to it. Sub-Committee No. 3 has completed a set of dimensions for standard malleable cast-iron and non-ferrous screwed fittings from $^1/_8$ inch to 6 inches. This report has passed the Sub-Committee and has been approved by the Sectional Committee. It will therefore appear in an early issue of MECHANICAL ENGINEERING.

Sub-Committee No. 1 is now considering the preliminary draft of its report on the revisions to the 125-lb. and 250-lb. flange standards issued by the Joint Committee in 1914.

Sub-Committee No. 2 has so far confined its activities to collecting information on the work which has already been done throughout the country in the design of flange joints for pressures above 250 lb. *Chairman,* C. P. Bliss; *Secretary,* A. C. Taylor.

Plain Limit Gages for General Engineering Work. The February 1921 issue of MECHANICAL ENGINEERING contained a questionnaire on the subject of Machine Fits which had been prepared by this Sectional Committee. This questionnaire was reprinted and 1000 copies distributed by mail to as many manufacturers and users of plain limit gages. The replies to the twenty-one questions it contained have been carefully studied by a Sub-Committee, which has just completed a 66-page report for the consideration of the Sectional Committee. Copies of this report are now in the hands of the members of the full Committee and a meeting is to be called during June. *Chairman,* E. C. Peck; *Secretary,* H. W. Bearce.

Bolt, Nut and Rivet Proportions. As previously reported this Sectional Committee was organized on March 16. The seven Sub-Committees which were appointed on that day have since been steadily at work securing information on present practice. These Sub-Committees are planning to prepare standards for (1) Large and Small Rivets, (2) Wrench-Head Bolts and Nuts, (3) Slotted Heads, (4) Track Bolts, (5) Carriage Bolts, (6) Special Bolts and Nuts for Agricultural Machinery, and (7) Body Dimensions and Material.

Small Tools and Machine-Tool Elements. The personnel of the Plan and Scope Committee mentioned in this page of the June issue has now been completed and the Committee is at work. Though it has so far issued no official report, it is probable that the first two projects which the Sectional Committee will be asked to undertake are (1) the reduction in the number of sizes of all the various kinds of machine tools and (2) the standardization of the tee (T) slots employed in these types of machines. The first of these will be accomplished most likely by the adoption of the "Preferred Number" method of determining standard sizes, while the second will of necessity be a compromise between the many sizes and proportions shown by the large amount of data already collected.

Color Schemes for Systems of Piping. This Sectional Committee has just been organized under the sponsorship of the National Safety Council and The American Society of Mechanical Engineers. A considerable amount of data on this subject has, however, been collected by the Sponsors during the past two years, so that the early issuance of a preliminary report may be expected.

Roller Transmission Chains. A series of four closely related standards has thus far been developed by this Joint Committee and published by the S.A.E. and the A.S.M.E. These standards cover (*a*) Roller Chain Dimensions including a System of Numbering, (*b*) Sprockets and their Tooth Form, (*c*) Minimum Breaking Strength for Standard Chains, and (*d*) Standard Nomenclature for Roller Chain-Components.

In connection with the work on the Roller-Chain Sprocket Cutters a slight change in the sprocket-tooth form has been suggested by a member of the Committee which, if adopted, will greatly simplify the present method of laying out the sprocket teeth. As a result of this suggestion the Committee is reconsidering its previous report.

The Sub-Committee which is making a preliminary study of the three remaining subjects, i.e., (*e*) Maximum Working Loads for Standard Chains, (*f*) Maximum Revolutions per minute for Sprockets and (*g*) Maximum Chain Velocities for Different Number of Teeth, states through its Chairman, Mr. G. M. Bartlett, that more research work at the plants of the manufacturers will be necessary before his Sub-Committee can submit a report to the Joint Committee.

Two Standard Specifications before the A.E.S.C. for Approval

Raw and Boiled Linseed Oil. Specifications for Purity of Raw Linseed Oil from North American Seed (D1–15) and for Purity of Boiled Linseed Oil from North American Seed (D11–15) were prepared by American Society for Testing Materials Committee D-1 on Preservative Coatings for Structural Materials. The development of these specifications was begun in 1908. Samples of linseed oil of known purity were obtained and specifications for analysis prepared; portions of these samples were distributed among competent chemists and the results of their examinations reported. Based upon these results, the specifications prepared were submitted to all the manufacturers of linseed oil in the United States with the request that the manufacturers comment upon their acceptability. The consensus of opinion was that work should be done on the examination of linseed oil from different crops of seed before adopting specifications. Additional work was carried on in the several years following, and in 1915 the revised specifications were adopted. Both standards have stood without revision since their adoption, although the committee is continuing to work to improve the specifications by additional methods of test.

Laboratory Methods of Sampling and Analysis of Coke. These methods were formulated by Committee D-6 of the American Society for Testing Materials in coöperation with the American

Chemical Society, the American Foundrymen's Association and the U. S. Bureau of Mines. The specifications are such that methods of coke analysis conform in as far as practicable, with methods of coal analysis, making due allowance for the difference in procedure desirable in the analysis for coke.

These two process standards are submitted by the American Society for Testing Materials to the American Engineering Standards Committee in accordance with the special procedure of the Committee, under which important standards in existence prior to 1920 may be approved without going through the regular process followed in new work.

The A.E.S.C. would be very glad to learn from those interested of the extent to which they make use of these specifications and to receive any other information regarding the specifications in meeting the needs of the industry.

Progress of Standardization in Belgium

Great strides toward standardization, particularly in the construction, metals, mining, and electrical industries of Belgium, are indicated in a report from the Association Belge de Standardization which has just been received by the American Engineering Standards Committee.

The report shows that the following standards have been approved for issue in Belgium: Rules for the Construction of Steel Roof Trusses, Rules for the Construction of Steel Tanks, Rules for the Construction of Galvanized Corrugated Roofs and Partitions, Standardization of Steel Bridges, Tentative List of Equal Angles, Standardization of Shafts and Pulleys, Standardization of Bolts and Rivets, Standard Requirements for Electrical Machinery, Electrotechnical Vocabulary.

These standards, with the exception of the Tentative List of Equal Angles, have been printed and copies are now available through the American Engineering Standards Committee. The Tentative List of Equal Angles is up for printing.

The report shows also that the following proposed standards have been published in the press of Belgium for criticism: Rules for the Design and Inspection of Reinforced-Concrete Structures, Chains (Dimensions of links; material; reception tests), Wire Cables for Cranes, Hoists, Elevators and Mining Purposes.

The Draft Specification for Methods of Analysis for Zinc Ores, Spelter, etc. is under consideration. It is also shown in the report that work on the following proposed standards is in the hands of Technical Committee: Cast-Iron Pipes and Fittings for Water Works, Rules for the Design of Shafting, Standardization of Tolerances, Dimensions of Paper, Drawing, etc.

On the subject of Flanges for Steel Tubes and on Chains (Dimensions of rings and hooks) decisions have been made to undertake standardization.

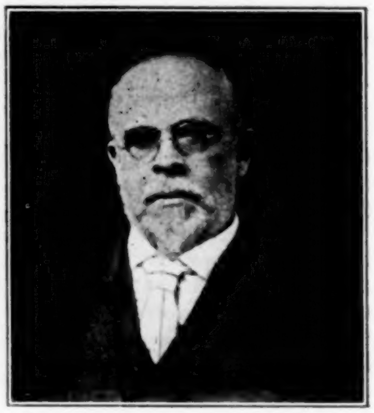
Copies of pending standards will also be available through the American Engineering Standards Committee, 29 West 39th St., New York, as soon as published.

The Specifications and Tests for Portland Cement, for which the American Society for Testing Materials is sponsor, have been advanced to the full status of "American Standard" by the American Engineering Standards Committee. These specifications, which have been developed as a result of the experience of the industry through several years, were first approved by the A.E.S.C. as Tentative American Standard in 1919. They were reäpproved in 1921 after agreements had been reached which eliminated slight differences between the Government and the commercial specifications, resulting in nationally recognized uniform specifications.

There are seven forms of nailed wooden boxes so universally used that they may be called the standard styles of nailed boxes. These boxes can be adapted to a wide range of uses, and it is the experience of the Forest Products Laboratory, Madison, Wis., that in meeting the majority of packing problems they are the most efficient of the nailed boxes. The advantages and disadvantages of each style, as revealed in laboratory tests and observations of boxes in commercial service, are given in a pamphlet recently issued by the Laboratory under the designation, Technical Note No. 164.

A. W. Gibbs, Chief Mechanical Engineer of the Pennsylvania System, Dies

Alfred Wolcott Gibbs, chief mechanical engineer of the Pennsylvania Railroad System, died on May 19, 1922. Mr. Gibbs was born at Fort Filmore, N. M., on October 27, 1856. He received his preparatory schooling at Rutgers College Grammar School and then studied for two years in Rutgers College, when he entered Stevens Institute of Technology, being graduated in 1878.



Alfred Wolcott Gibbs

In March, 1879 Mr. Gibbs entered the service of the Pennsylvania Railroad Co. as a special apprentice at the Altoona Shops, continuing such service until June 1, 1881, when he became draftsman with the Richmond and Danville Railway. In 1886 he was appointed master mechanic of the Atlantic and Charlotte Division of that line and two years later became superintendent of motive power of the Central of Georgia Railway. When that position was abolished he was again appointed master mechanic on the Atlantic and Charlotte Division.

In 1893 Mr. Gibbs reëntered the service of the Pennsylvania Railroad Co. as assistant mechanical engineer and nine years later was advanced to the position of superintendent of motive power of the Philadelphia, Wilmington & Baltimore Railroad Co. On January 1, 1913, Mr. Gibbs was appointed general superintendent of motive power of the Pennsylvania Railroad Co. In 1911 he assumed the duties of the newly created position of chief mechanical engineer of that line and under the reorganization in 1920 became chief mechanical engineer of the Pennsylvania System.

Mr. Gibbs became a member of The American Society of Mechanical Engineers in 1920. He was also a member of the Mechanical Division of the American Railway Association, of the American Engineering Standards Committee, the American Railway Engineering Association, the American Society of Naval Engineers, of the Board of Managers of the Franklin Institute, of the Board of Managers of the Philadelphia Institute and Free Library and Past-President of the American Society for Testing Materials.

Arthur J. Wood Appointed to Succeed Professor Fessenden at Pennsylvania State College

Arthur J. Wood, professor of railway mechanical engineering at Pennsylvania State College, has been appointed head of the department of mechanical engineering to succeed Professor E. A. Fessenden. Professor Fessenden goes to Rensselaer Polytechnic Institute in the fall.

Professor Wood was graduated in 1896 from Stevens Institute of Technology. He was associate editor of the *Railroad Gazette*, and preceding his appointment to the State College faculty he was an instructor in mechanical engineering at Worcester Polytechnic Institute and professor of mechanical and electrical engineering at Delaware College. He went to Pennsylvania State College as assistent Professor of Experimental Engineering in 1904 and was made associate professor of railway mechanical engineering in 1909.

Recently he has been in direct charge of the Engineering Experiment Station at State College, where he became greatly interested in problems of heat transmission. He has derived a method for testing insulation and in coöperation with a number of other experiment stations has carried on extensive insulation tests. He has developed the course in railway mechanical engineering and has written a textbook on locomotive operation. He is the chairman of the Central Pennsylvania Section of The American Society of Mechanical Engineers. He has been a member of The American Society of Mechanical Engineers since 1907.

NEWS OF OTHER SOCIETIES

American Water Works Association

In a convention notable for close adherence to program, the American Water Works Association met in Philadelphia at the Bellevue-Stratford Hotel the week of May 15, 1922. Fifty papers and committee reports, not including the topical discussions on Superintendent's Day, were presented. With the exception of Wednesday afternoon, which was the occasion of a boat ride on the Delaware, the entire time of the convention was devoted to papers and discussions.

In his presidential address, Dr. Edward Bartow stressed the duties of the water-works superintendent, particularly his relations with the public. Leonard Metcalf, member of the A.S.M.E., presented a valuable paper on the Improved Financial Condition of Water Works. Filtration, chlorination, tastes and odors, the effects of waste matters, and water softening were a few of the topics touched upon in other papers. Eight sub-committee reports on the work of the Council on Standardization were among the most valuable features of the week. The meetings of the Chemical and Biological Section were crowded throughout, and Superintendents' Day was an unusually successful undertaking.

Robert Morse, chairman of the Publication Committee, gave in his report a classification of the membership in groups such as executives, superintendents, engineers, chemists, etc. Of the entire membership, 43 per cent were classified as engineers.

An unusually attractive display of the Water-Works Manufacturers' Association featured the convention. It was voted to hold the meeting next year in Detroit. There was no opposition to the report of the Nominating Committee and the following officers were elected: President, W. S. Cramer; Vice-President, George W. Fuller; Treasurer, W. W. Brush; and Trustees, George W. Batchelder and J. W. Ellms.

National Electric Light Association

The forty-fifth convention of the National Electric Light Association, held in Atlantic City May 15–17, brought together delegates and guests from every corner of the United States to attend sessions that marked exceptional progress in the industry. The Association is undoubtedly in more intimate contact with its problems than ever before, and the convention this year points to continued solid progress. The industry is unanimously back of the better business movement and "Electrify America" is a slogan fast becoming a fact.

One of the high spots of the week was the dramatic demonstration by the American Telephone & Telegraph Company which made possible a half-hour of simultaneous meeting with the Pacific Coast association. The place of honor on the crowded program was given for the first time in the history of the organization to a symposium on business development, presented by Henry L. Doherty, Guy E. Tripp, W. E. Robertson, W. W. Freeman, Farquson Johnson and H. A. Lane.

It was necessary to hold a number of parallel sessions during the week. In addition to the general sessions there were technical, commercial, accountants, and public-relations sessions.

The feature of the meeting of most importance to mechanical engineers was the presentation of the Prime Movers Report which had been prepared under the direction of H. P. Liversidge, Chairman of the Committee on Prime Movers. This document comprises 340 pages and provides much valuable information showing progress in central-station development. Due to the delay in printing the report, the discussion was limited to a record it included which showed idle time of a number of large generating units.

O. F. Jungren of the General Electric Company and F. Hodgkinson of the Western Electric and Manufacturing Company discussed the respective merits of single- and double-drum turbines. I. E. Moultrop, of the Edison Electric Illuminating Company, stated his opinion that turbine reliability was of much greater importance than efficiency.

John Anderson of the Milwaukee Electric Railway and Light Company presented some of the facts regarding the installation of pulverized fuel in the Lakeside Plant, which, after fourteen months of operation, has generated 200,000,000 kw-hr. without interruption due to prime mover or generating equipment. This station was designed for a thermal efficiency of 19.2 per cent and a boiler and economizer efficiency of 88 per cent. Mr. Anderson was confident that these efficiencies could be obtained under normal operating conditions with the complete installation. Nevertheless, using coal averaging from 9000 to 13,500 B.t.u. per lb. and with a night load only 30 per cent of the day load, an average station water rate of 12.7 lb. per kw-hr. has been obtained. Boiler efficiencies during steaming period have varied from 84.2 to 85.9 during the past six months. The overall boiler-room efficiency varied from 83.2 to 84.48 during the same period, and 19,097 B.t.u. per kw-hr. (net) or a thermal efficiency of 17.88 has been achieved. Mr. Anderson stated that preheating the air to the furnace will not entirely eliminate feeding trouble, and that coal to feed regularly must have less than 8 per cent moisture. To remove ash in the smoke a washer was installed in the underground breeching in a ten-day test. This washer, which consists of a curtain of water, caught 70 per cent of the ash.

At the concluding general and executive session the following officers were elected: President, Frank W. Smith; vice-presidents, Walter H. Johnson, Franklin T. Griffith, J. E. Davidson and R. F. Pack; Treasurer, Walter Neumuller.

American Boiler Manufacturers' Association

The thirty-fourth Annual Convention of the American Boiler Manufacturers' Association was held at Shawnee-on-Delaware, Pa., June 5, 6 and 7. President A. G. Pratt of the Babcock & Wilcox Co. opened the meeting with an address dealing with the attitude of the Federal administration toward the trade association and favoring coöperation along methods outlined at the conference of trade associations called by Secretary Hoover.

Dr. M. W. Alexander, managing director of the National Industrial Conference Board, described the methods and purposes of the Board and showed some of the results of its analyses and studies on the labor supply, the rise and fall of wages as compared with the cost of living, etc.

In the evening E. C. Fisher of the Wickes Boiler Co. presented a paper on A Study of Thickness of Shell Plates in Return-Tubular Boilers and R. Sanford Riley, president of the Sanford Riley Stoker Co., exhibited films of a stoker fire in operation.

On Tuesday morning E. R. Fish, who represents the Association on the Boiler Code Committee of the A.S.M.E., told of the work of that Committee, and Chas. E. Gorton, chairman of the Uniform Boiler Law Society, reported the progress of boiler legislation in several states. J. F. Scott, chairman, and C. O. Myers, secretary-treasurer of the National Board of Boiler and Pressure-Vessel Inspectors, gave reports on the progress of that organization. Reports were also presented by the Conference Committee with the Stoker Manufacturers' Association, the Committee on Ethics and the Committee Appointed to Investigate the Proper Setting Heights of Hand-Fired Return-Tubular Boilers.

The last named Committee recommended that a committee be named to confer with a similar committee to be appointed by the Affiliated Smoke Prevention Bureaus, meeting in Cleveland in the near future, with the view of taking coöperative action to standardize setting heights in the various districts that would meet with the approval of the boiler manufacturers and the legal authorities having the matter in charge.

On Wednesday morning the meeting was addressed by Charles Aubrey Eaton of the American Educational Association on the broad effects of education on citizenship and political, industrial and social relations, the satisfactory adjustment of which depends upon the creation of right thinking and intelligence rather than the accumulation of undigested knowledge.

C. S. Blake, president of the Hartford Steam Boiler Inspection and Insurance Co. and chairman of the sub-committee of the A.S.M.E. Boiler Code Committee, presented for discussion and advisement the tentative code on Inspection of Steam Boilers now being formulated.

The Buckwood Inn at which the convention was held afforded unusual opportunities for entertainment between sessions, not the least of these being the nationally known golf course on which several tournaments were held. At the banquet on Tuesday evening C. V. Kellogg acted as toastmaster.

LIBRARY NOTES AND BOOK REVIEWS

A Dictionary of Applied Physics

A Dictionary of Applied Physics. Edited by Sir Richard Glazebrook. Vol. 1. Macmillan and Co., Ltd., London, 1922. Cloth, 6×9 in., 1067 pp., illus., diagrams, $15.

During the past twenty-five years the applications of physics to industry have grown enormously. Governments, universities and manufacturers have undertaken research upon a large scale and a vast amount of information of practical usefulness has accumulated.

The development of the science has paralleled that in the sister science, chemistry, with one important difference. While the chemist has from time to time published cyclopedias and dictionaries from which he could quickly ascertain the salient facts concerning any subject, the results of the labors of physicists have remained scattered in the proceedings of learned societies or stored in the brains of the workers themselves. The engineer or manufacturer interested in getting the latest and most accurate information upon the subject with which he was concerned, faced a long search in libraries and a tedious inquiry for experts.

The Dictionary of Applied Physics is the first serious attempt to remedy this condition. It will appear in five volumes of 800 to 1000 pages, and will contain modern information on the wide range of subjects included within its title. The editorial direction has been placed in the competent hands of Sir Richard Glazebrook, and the assistance of the most competent physicists of Great Britain has been obtained.

In order that it may not be necessary for the individual to purchase all the volumes, the work is arranged so that all of any subject is contained in a single volume. Within each volume, the arrangement is alphabetical. The first volume covers Mechanics, Engineering and Heat, and is of particular interest, therefore, to mechanical engineers.

The following list of the contributors and subjects of the important articles indicates the scope and authoritativeness of the first volume: George S. Baker, Ship Resistance and Propulsion; Reginald A. Batson, Determination of Elastic Constants and the Testing of Materials of Construction; Dr. G. T. Bennett, Gyroscope; Charles H. Beeleid, Kinematics of Machinery; Andrew Cruickshank, Reciprocating Steam Engine; William E. Dalby, Balancing of Engines and Prime Movers; Robert Dawson, Development of the Steam Turbine; Aubrey T. Evans, Water-Cooled Petrol Engine; Dr. Angus R. Fulton, Hydraulics; James H. Hyde, Dynamometers, and Mechanical Powers; Dr. Horace Lamb, Fourier's Series, Simple Harmonic Motion, Stream-Line Motion, and the Mathematical Theory of Conduction of Heat; J. W. Landon, Strength of Structures; Dr. Hyman Levy, Principles of Dynamical Similarity; Research Staff of the General Electric Company, Air Pumps; R. V. Southwell, Theory of Elasticity; Dr. T. E. Stanton, Friction; W. J. A. Butterfield, Fuel Calorimetry; Sir Dugald Clerk, Thermodynamics of Internal-Combustion Engines, and Some Typical Internal-Combustion Engines; Dr. Arthur L. Day, Realization of the Absolute Scale of Temperature; Sir J. A. Ewing, Liquefaction of Gases, Refrigeration, Theory of the Steam Engine, and Thermodynamics; Dr. Ernest H. Griffiths, Mechanical Equivalent of Heat; Dr. Ezer Griffiths, Bomb Calorimeters, Calorimetry; Latent Heat Pyrometry, Resistance Thermometers, and Thermocouples; William B. Hardy, Boundary Conditions in Lubrication; Dr. John L. Haughton, Thermostats; William F. Higgins, Flash-Point Determination, Thermometry, and Viscometry; Alfred W. Porter, Thermal Expansion; David R. Pye, Specific Heat of Gases; F. H. Schofield, Conduction of Heat, and Convection of Heat.

Bibliographies are frequently given and an index to authorities cited is added to the volume. The articles are sufficiently long to be satisfactory summaries of present knowledge. The work, judging by the first volume, will be an invaluable work of reference to every one who is interested in the field of engineering research.

Harrison W. Craver.

Metal Cutting Tools

Metal Cutting Tools. By A. L. DeLeeuw. First edition. McGraw-Hill Book Co., New York, 1922. Cloth, 6×9¹/₄ in., 328 pp., 306 figs., price $3.50.

Mr. DeLeeuw's book as compared, for example, with the classical work of Fred W. Taylor on The Art of Cutting Metals, belongs to a distinctly new era.

Some 25 years ago tools were primarily built for general purpose work. There were a few specialized shops using quantity production on what was supposed to be single-purpose tools, such as sewing machines and typewriters, but the number of these shops was very small and the tools which they employed were really crude adaptations of standard tools to the particular tasks performed.

In the last quarter of a century, primarily under the leadership of the automobile industry, a profound change has taken place. Single-purpose tools, sometimes of considerable size and not unusually of quite complicated construction, have been developed to supply the millions of parts on repetition work that modern standardized industry demands.

When a tool has to perform one function or one set of functions day in and day out, possibly in a number of plants, it becomes worth while to devote a good deal of attention and research to the particular performance of that tool, because even a slight saving in the cost of production per part made, would amply repay for the time and labor spent. We see therefore the appearance of extensive and highly organized investigations on the performance of various machine tools, of which a good example may be seen in the recent paper by Professor Coker before the Institution of Mechanical Engineers.

The book on Metal Cutting Tools by A. L. DeLeeuw represents an interesting attempt to give a synopsis of our knowledge of the facts underlying the performance of the various classes of tools and to discuss various tools in the light of these underlying facts. From this point of view Chapter 1 is perhaps of the greatest interest, as it explains the fundamental conditions affecting the action of a cutting tool and thus provides the basis for understanding the general principles of design of metal-cutting tools.

The book covers the various types of planer tools, boring tools, milling cutters, form and shear tools, generating tools, thread-cutting tools and hollow mills. In discussing every one of these types of tools the author starts with an analysis of the conditions underlying operation and from that builds up first the ideal conception of what a tool of that particular class should be, proceeding from this to a description, and at times criticism, of the particular tools now available.

The book is written in remarkably simple language and (which is by no means as usual as it should be) is not encumbered by unnecessary mathematics and antiquated tables of experimental data.

L. Cammen.

Book Notes

Annals of the American Academy of Political and Social Science. May, 1922. Paper, 6×9 in., 315 pp., $1.

The American Academy of Political and Social Science has done a great service to all the professions by bringing together for the first time in one collection the concepts of what constitutes the attainment of the ideals of a profession, in distinction from those of a vocation. As respects the Engineering Societies, the authors representing the leading societies have, by long contact in their respective organizations, not only themselves advanced the high ideals of their professions but have contributed personally, both in conference and in committee, to the adoption of those principles which they describe in their several articles. Every engineer wishing to stand for the advancement of his profession should read this entire issue of The Annals.

Cours de Mécanique Appliquée. By Marcel Lamotte. Gauthier-Villars et Cie, Paris, 1922. Paper, 6×10 in., 282 pp., diagrams, 25 fr.

Professor Lamotte feels that most textbooks of applied mechanics require more extensive knowledge than the usual student possesses and are unnecessarily difficult. He has prepared this book, not to replace the more elaborate treatises on the subject, but to prepare the student for them, so that he may derive the most profit from their perusal. This is accomplished by presenting, in the simplest form possible, some of the questions that affect the applications of mechanics. He is less concerned in establishing general theories than in showing, by examples, how practical problems may be solved.

Cyaniding Gold and Silver Ores. By H. Forbes Julian and Edgar Smart. Third edition, revised and enlarged. J. B. Lippincott Co., Philadelphia, 1921. Cloth, 6×9 in., 417 pp., diagrams, tables, $12.50.

The second edition of this well-known treatise appeared in 1907. Work upon the present edition began in 1914, was interrupted by the death of Mr. Smart and by the Great War, but was finally completed by A. W. Allen. Much new material dealing with recent modifications in the theory and operation has been added and the chapters have been rearranged to secure greater uniformity. The principal additions are in connection with colloidity and absorption; the theory of gold precipitation on charcoal; milling in cyanide solution, flotation and cyanidation; zinc-box practice; deoxidizing solutions; counter-current decantation; aluminium, sodium sulfide and charcoal precipitation; agitation, slime-settlement and filtration equipment.

Fuel and Refractory Materials. By A. Humboldt Sexton. New edition, revised by W. B. Davidson. D. Van Nostrand Co., New York, 1921. Cloth, 6×9 in., 382 pp., illus., diagrams, tables, $4.

No important alterations have been made in the original text of this well-known work, but minor corrections have been made throughout. The chapters on liquid and gaseous fuels have been modified and enlarged, and the chapter on by-products has been rewritten. The chapters on fuel testing and refractories have been modernized and enlarged. The book discusses the important industrial fuels, metallurgical furnaces, pyrometry, calorimetry, fuel testing and the refractory materials used for furnaces and crucibles.

Lapping and Polishing. By Edward K. Hammond. First edition. Industrial Press, New York, 1921. (*Machinery's* blue books.) Paper, 6×8 in., 60 pp., illus., $0.50.

This pamphlet reviews modern practice in lapping operations, in the light of the improvements developed during recent years, and also gives an account of current methods for polishing tools and parts.

Manual of Flotation Processes. By Arthur F. Taggart. John Wiley & Sons, Inc., New York, 1921. Cloth, 6×9 in., 181 pp., diagrams, $3.

Widespread understanding of the physical principles underlying flotation phenomena and of the diversity of flotation processes has been delayed, partly by the apparent complexity of the phenomena and the difficulties of investigation, in part by the attitude of corporations owning patents on flotation processes. It is the purpose of this book, in part, to counteract the further spread of false conceptions, by setting forth some of the facts that contradict them, in part to describe apparatus and methods of testing which will aid investigators in their researches; and finally to give some generalizations from mill practice, by means of which the investigator may translate laboratory results into commercial operations.

Manufacture of Pulp and Paper. Vol. 3. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., illus., diagrams, $5.

This is the third volume of the course of instruction in pulp and paper manufacture prepared by the pulp and paper industry of North America for those actively engaged in the industry. Previous volumes have been devoted to the elementary scientific knowledge—physical, chemical and mathematical—needed by the paper maker; the present volume takes up the actual manufacturing processes. It is, the editor announces, the first work in English dealing solely and comprehensively with wood-pulp manufacture. The various sections have been prepared by specialists. They describe the properties of pulpwood, its preparation, the manufacture of mechanical, sulphite, soda and sulphate pulps, and the treatment, refining, testing and bleaching of pulp.

Metric System for Engineers. By Charles B. Clapham. Dutton & Co., New York, 1922. (Directly useful technical series.) Cloth, 6×9 in., 181 pp., $6.

This book is not concerned with the controversy regarding the metric system. Its object is to give a full, practical explanation of the system as it is met in engineering calculation and measurement, for use by draftsmen, mechanics and engineers. After an introduction explaining basic principles, the simple measures of length, area, volume, capacity and weight are discussed, with special attention to the usual measuring tools found in workshops and drafting rooms. Compound measures used in engineering are then described, with the derivation of the corresponding British equivalents. Succeeding chapters give tables of the commoner engineering constants in British and metric units, and examples of the alteration of numerical constants in formulas when metric values are to be used.

Motor Truck Transportation. By F. Van Z. Lane. D. Van Nostrand Co., New York, 1921. Cloth, 6×9 in., 153 pp., illus., $2.

A practical presentation of the principles of truck-operating cost; operating efficiency and cost records; operating cost laws; truck details, such as bodies, loading and unloading devices, trailers and semi-trailers, and tires; and the factors that determine the fields of economical operation. Gives no attention to design or manufacture.

Physique Elementaire et Theories Modernes. By J. Villey. Part 1. Molecules and atoms. Gauthier-Villars & Co., Paris, 1921. Paper, 6×10 in., 197 pp., 15 francs.

The author has prepared a work, less scholastic than usual textbooks and more suited for reading, in which the essential phenomena of physics are set forth and explained by the most modern theories. Attention is especially directed to those phenomena which have received industrial application. The work is intended for the general public desirous of information about the fundamentals of physics and modern theories, as well as for use as a text book.

Protective Relays. By Victor H. Todd. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 274 pp., illus., diagrams, $2.50.

This book attempts to cover the subject from first principles to the protection of high-tension networks, in a manner suited to the needs of operators and testers with a fair knowledge of electricity, and also of designers.

Sewerage and Sewage Disposal. By Leonard Metcalf and H. P. Eddy. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 598 pp., illus., diagrams, $5.

This work is practically a one-volume abridgment of the three-volume treatise American Sewerage Practice published by these authors in 1914–1915. It is intended for class use in engineering schools, but reflects the viewpoint of the engineer, not the teacher, and presents the information that its authors believe young students should acquire before taking up work in the field of sewerage engineering.

Short Course in the Testing of Electrical Machinery. By J. H. Morecroft and F. W. Hehre. Fourth edition, revised and enlarged. Van Nostrand Co., New York, 1921. Cloth, 6×9 in., 220 pp., diagrams, $3.

All students of engineering at Columbia University are required to take courses in testing direct and alternating-current machinery. These notes are prepared to meet the needs of students in mining, mechanical and civil engineering, who have not studied the theory of electrical machinery, and hence need a brief summary of it as preparation for the laboratory work. Besides giving specific directions for the tests, a brief analysis of the characteristics of the machines is given. The new edition includes new material on batteries, illumination, measurement of electrical energy and other subjects of interest to engineers generally.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACETYLENE

High-Pressure Apparatus. High-Pressure Acetylene Apparatus (Hochdruck-Acetylenapparat), K. Matzinger. Autogene Metallbearbeitung, vol. 15, no. 6, Mar. 15, 1922, pp. 80–82, 4 figs Describes apparatus used for Schoop's metal-spraying process built by Continental Light & Apparatus Construction Co. in Zurich-Dübendorf.

AERIAL PHOTOGRAPHY

Cameras. Practical Uses of Aerial Photography. Aviation, vol. 12, no. 15, Apr. 10, 1922, pp. 424–426, 5 figs. Describes Fairchild camera used for producing aerial map of New York City.

AERONAUTICAL INSTRUMENTS

Air-Speed Recorder. Manometer For Recording Air Speed, C. Wieselberger. Aerial Age, vol. 15, no. 6, Apr. 17, 1922, pp. 131–132, 3 figs. Describes instrument made at Göttingen aerodynamic laboratory, answering following conditions: (1) Must respond quickly so that all speed variations will be correctly recorded. (2) Must not be affected by rectilinear or curvilinear accelerations. Hence, movable parts must be counterbalanced. Translated from Zeit. für Flugtechnik u. Motorluftschiffahrt.

Electrical. Electrical Instrument Equipment for Aircraft, Edgar A. Griffiths. Beama, vol. 10, no. 4, Apr. 1922, pp. 299–307, 16 figs. Characteristics of engine revolution indicator, oil pressure transmitter, thermometric instruments, rate of climb meter, gyroscopic devices, and transmitting compass.

AERONAUTICS

Seaplane Coefficients. Full Scale Seaplane Coefficients, Max M. Munk. Aviation, vol. 12, no. 17, Apr. 24, 1922, pp. 482–483, 1 fig. Lift and drag coefficients of Brandenburg seaplane determined in free-flight tests.

AIRCRAFT

Research. The Progress of Research, R. K. Bagnall-Wild. Aerial Age, vol. 15, nos. 4 and 5, Apr. 3 and 10, 1922, pp. 78–79 and 103–104. Aero engine research; navigation; machines; materials. See also Flight, vol. 14, no. 8, Feb. 23, 1922, pp. 122–124.

AIRCRAFT CONSTRUCTION MATERIALS

Brazing. Investigation of Dip Brazing with High Melting Point Brass. Air Service Information Circular, vol. 3, no. 297, Feb. 15, 1922. Continuation of investigation recorded in A.S.I.C. vol. 3, no. 203. Determination of best flux and heat treatments for brass of this type.

AIR COMPRESSORS

New Efficient Type. A New Air Compressor. Oil Eng. & Finance, vol. 1, no. 2, Mar. 25, 1922, pp. 378–380, 2 figs. Design by A. H. Sproule which overcomes some of previous losses.

Rotary. The Planche Rotary Compressor (Compresseur rotatif, système R. Planche), Lucien Fournier. Génie Civil, vol. 80, no. 12, Mar. 25, 1922, pp. 275–277, 10 figs. Describes rotary air compressor based on principle of conchoidal motion of a disk-piston, and gives results of tests.

AIRPLANE ENGINES

Detonation. The Background of Detonation, Stanwood W. Sparrow. Aerial Age Weekly, vol. 15, no. 9, May 8, 1922, pp. 201–203, 206, 4 figs. Discussion of charge temperatures and pressures before and after combustion.

Installation. Engine Installation, Bagnall-Wild Aeronautical Jl., vol. 26, no. 136, Apr. 1922, pp. 121–129 and (discussion) 130–136, 1 fig. Discusses lack of development. Principal features required for evolution of a sound installation, and how far these aims may be realized in the light of present-day experience.

Large-Bore. An American Development in Large-Bore Aircraft Engines, Herbert Chase. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 852–856, 4 figs. Wright Aeronautical Corp. design for Navy Zeppelin-type ships which develops 400 b.hp. at 400 r.p.m. Accessibility for repair in air one of outstanding features.

Light-Weight. Special Light-Weight Aero Engine A. E. L. Chorlton. Aeronautical Jl., vol. 26, no. 136, Apr. 1922, pp. 137–148, 1 fig. Discusses the more important types of engines and gives principal characteristics in tables.

Starting at Low Temperatures. Starting Aircraft Engines at Low Temperatures. Aviation, vol. 12, no. 18, May 1, 1922, p. 505. Abstract from technical memorandum no. 29, Canadian Air Board, by Prof. Robb at Edmonton, Alberta.

Wright Six-Cylinder. The Wright 6-Cylinder Airship Engine. Aviation, vol. 12, no. 18, May 1, 1922, pp. 504–505, 1 fig. First American high-power airship engine develops 350–400 hp. and has low fuel and oil consumption.

AIRPLANE PROPELLERS

Design. Notes on Propeller Design, Max M. Munk. Aerial Age Weekly, vol. 15, nos. 8 and 10, May 1 and 15, 1922, pp. 178–179 and 225–226. May 1: Energy losses, in particular that of friction between air and blade. May 15: Distribution of thrust over a propeller blade. Tech. Note N.A.C.A.

Theory. The Theory of the Screw Propeller, A. Betz. Aerial Age, vol. 15, no. 5, Apr. 10, 1922, pp. 105–106, 2 figs. Discusses our inadequate geometrical presentation and mathematical treatment of hydrodynamical phenomena connected with propeller and shows possibility of investigating phenomena in vicinity of propeller so as to be able to calculate its action on basis of fewer experimental values. Translated from Die Naturwissenschaften, No. 18, by N.A.C.A.

Variable Pitch. The "Universal Propeller," David L. Bacon. Aerial Age Weekly, vol. 15, no. 7, Apr. 24, 1922, pp. 152–153, 3 figs. Brief description of developments by Spencer Heath. May also be used in helicopters.

AIRPLANES

Commercial. The Commercial Aeroplane, W. H. Sayers. Aeroplane, vol. 22, nos. 5, 6, 8, 10, 11, 12 and 15, Feb. 1, 8, 22, Mar. 8, 15, 22 and Apr. 12, 1922, pp. 83–84, 99–100, 138, 171–172, 191–194, 207–208 and 263–264, 4 figs. Feb. 1: Deficiencies of present type of aircraft, and need for radical improvement in aerodynamic and structural design. Feb. 8: Incentives to stagnation in design. Feb. 22: Arrest of aerodynamic development. Mar. 8: Where research has so far failed. Mar. 15: How airplane can be improved. Mar. 22: A possible type of economical airplane.

Flight Phenomena. Mechanical Phenomena of the Airplane in Flight (Mechanische Vorgänge beim fliegenden Flugzeug), H. Schuster. Glasers Annalen, vol. 90, nos. 5 and 6, Mar. 1 and 15, 1922, pp. 67–74 and 83–89 and (discussion) pp. 89–90, 29 figs. Review of what has been accomplished in fathoming secrets of flight phenomena. Deals with action of air forces on bodies and surfaces, especially effect of air resistance on aerofoil; design and stability of aerofoils; azimuth and altitude steering; high-altitude motors, etc.

Fire Elimination. Eliminating Fires in Airplanes, C. H. Butman. Aviation, vol. 12, no. 18, May 1, 1922, p. 508. Special study of subject by Air Service shows considerable progress made in past year.

Guiding Through Fog. The Loth Guide Cable for Flying in Fog. Aviation, vol. 12, no. 15, Apr. 10, 1922, pp. 422–423, 3 figs. Fundamental principle rests on fact that if high-frequency a.c. current is sent through cable earthed at each end, a magnetic field is created, which can be detected by receivers in airplane. System similar to directing ships in fog.

Handley Page W. 8b. The Handley Page W. 8b. Aeroplane, vol. 22, no. 16, Apr. 19, 1922, pp. 280–281, 12 figs. Description of design to be used on Handley Page service, modification of well-known W. 8.

Suspended Wing for Test. Aeroplane Will Carry Suspended Wing in Test. Aerial Age Weekly, vol. 15, no. 7, Apr. 24, 1922, p. 151. Full size wing to be tested for first time at Langley Field Laboratory of Nat. Advisory Com. for Aeronautics. Inverted and supported from plane by three wires.

Theory of Stability. A Theory and Its Proof, G. A. Spratt. Aviation, vol. 12, no. 18, May 1, 1922, pp. 510–511, 2 figs. Some theoretical considerations in the design of gliding and soaring aircraft, especially low-power sport airplanes.

Wibault Night Bomber. The Wibault Night Bombing Biplane, John Jay Ide. Aviation, vol. 12, no. 18, May 1, 1922, p. 509. French two-seater fitted with 600-hp. Renault engine has useful load to total weight ratio of 52 per cent.

AIRSHIPS

Non-Rigid. Trials of Goodyear Type AC Airship. Aviation, vol. 12, no. 14, Apr. 3, 1922, pp. 395–396. Nonrigid military airship of novel type makes successful trials at Goodyear-Akron air station. Aeromarine 130 hp. U6D engines; volume, 185,000 cu. ft.; speed, 65 m.p.h.; propeller speed, 775 r.p.m.

Rigid. Rigid Airships in the United States Navy, R. G. Pennoyer. U. S. Naval Inst. Proc. vol. 48, no. 4, Apr. 1922, pp. 517–529. Brief historic sketch. Cause of crashing of ZR-2. A German rigid for U. S. Some facts and figures on latest types; performance; value to Navy.

Surface Area. Determination of Surface Area for Airships, Edward P. Warner. Aviation, vol. 12, no. 16, Apr. 17, 1922, pp. 450–451, 1 fig. Discusses use of Lieutenant Diehl's formula.

Testing Models. Hydrostatic Test of an Airship Model. Aerial Age Weekly, vol. 15, no. 7, Apr. 24, 1922, pp. 154–155, 158, 166, 4 figs. Goodyear Rubber Co. model studies with both ballonets empty, forward ballonet filled with air, rear ballonet filled with air, and both ballonets filled with air.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Calite. Calite—A New Heat Resisting Alloy. Automotive Industries, vol. 46, no. 18, May 4, 1922, p. 955. New heat-resisting alloy containing aluminum, nickel and iron which resists oxidization up to 2200 deg. fahr.

Cobalt-Tungsten. Cobalt-Tungsten Alloys (Kobalt-Wolframlegierungen), Karl Kreitz. Metall u. Erz, vol. 19, no. 6, Mar. 22, 1922, pp. 137–140, 1 fig. A diagram of state for cobalt-tungsten alloys is

Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

plotted and conditions for obtaining a faultless casting are determined.

Electrochemistry. The Electrochemistry of Metal Alloys (Die Elektrochemie der Metallegierungen), R. Kremann. Metall, no. 5, Mar. 10, 1922, pp. 53–55. Effect of precipitation on behavior and composition of alloys.

Nickel. See NICKEL ALLOYS.

Zinc. See ZINC ALLOYS.

ALUMINUM

Plate, Decomposition. Decomposition of Aluminum Plate (Zersetzungserscheinungen an Aluminiumblechen), H. Kropf. Metall-Technik, vol. 48, no. 8–9, Feb. 25, 1922, pp. 68–69. Gives results of investigations carried out by Prof. Heyn and Bauer on three different kinds of aluminum plate showing signs of decomposition.

ALUMINUM ALLOYS

Aluminum-Silicon. Aluminum-Silicon Alloys, Zay Jeffries. Chem. & Met. Eng., vol. 26, no. 16, Apr. 19, 1922, pp. 750–754, 15 figs. Coming into use because of superior casting qualities; history, technical properties, and characteristics.

Alloys of Aluminum with Silicon, H. Sutton. Metal Industry (Lond.), vol. 20, no. 16, Apr. 21, 1922, pp. 365–366, 2 figs. Some investigations of ternary and more complex alloys.

Bronzes. Aluminum Bronze, An Alloy of Strength. Wallam Dint Williams. Raw material, vol. 5, no. 3, Apr. 1922, pp. 105–109, 15 figs. Discusses an alloy, of 90 per cent Cu and 10 per cent Al, its properties, macrographic examination, casting, etc. Taken from Révue de Métallurgie.

Cerium, Influence of. Influence of Cerium on Aluminum and Other Light Metal Alloys, Josef Schulte. Metal Industry (N. Y.), vol. 20, no. 4, Apr. 1922, pp. 142–144, 1 fig. Describes experiments carried out with view to improving melting and soldering of light metals. Translated from Metall und Erz, May 22, 1921.

Failure, Cases of. Some Cases of Failure in "Aluminium" Alloys, W. Rosenhain. Metal Industry (N. Y.), vol. 20, No. 4, Apr. 1922, p. 140, 2 figs. Shows that many of aluminum alloys which fail are not really aluminum alloys. Read before British Inst. Metals.

High-Strength. New Aluminum Alloys of High Strength. Chem. & Met. Eng., vol. 26, no. 15, Apr. 12, 1922, pp. 689–694, 5 figs. Digest of eleventh report of Alloys Research Committee of British Instn. Mech. Engrs. Properties of some alloys; permanence and constitution of alloys; age-hardening with magnesium and silicon.

"Y Alloy." Y Alloy (Aluminum-Copper-Nickel-Magnesium). Chem. & Met. Eng., vol. 26, no. 17, Apr. 26, 1922, pp. 785–787, 6 figs. A light aluminum alloy having strength of soft steel and good ductility; easy to cast and roll; retains its desirable properties in gas-engine parts working at 250 deg. cent.; immune from season cracking and corrosion.

AMMONIA

Refrigerating Capacity of. A Pound of Ammonia, John E. Starr. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 11–12. Method by which amount of refrigeration can be computed directly from weight of ammonia boiled per hour.

AMMONIA COMPRESSORS

Dry and Wet Methods. Operating Ammonia Compressors, W. S. Doan. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 17–18, 3 figs. Relative merits of two methods of compression.

APPRENTICES, TRAINING OF

New Plan. A Constructive Apprenticeship Movement. Sheet Metal Worker, vol. 13, no. 5, Mar. 31, 1922, pp. 153 and 161. Discusses new plan approved by employer and employee, in operation in New York, and recommended by New York Building Congress.

ASBESTOS

Utilization of Waste. The Utilization of Asbestos Waste. India-Rubber Jl., vol. 63, no. 15, Apr. 15, 1922, pp. 15–16, 1 fig. Difference of asbestos from other organic fiber makes this special problem. Suggestions of various uses for same.

ASH HANDLING

Plants. Ash-Removal Plants for Furnaces (Entaschungsanlagen für Feuerungen), P. Ledar. Wärme, vol. 45, no. 2, Jan. 13, 1922, pp. 31–33, 16 figs. Describes recent German and English patented improvements.

ASPHALT

Trinidad's Pitch Lake. Trinidad's Famous Pitch Lake, Col. H. A. Judd. Petroleum Times, vol. 7, no. 171, Apr. 15, 1922, pp. 501–502, 4 figs. Description giving some idea of its value as a source of supply.

ATOMS

Artificial. Artificial Disintegration of the Elements, Ernest Rutherford. Chem. Soc. Jl., vol. 121–122, no. 713, Mar. 1922, pp. 400–415, 4 figs. Concludes that atoms are such stable structures and nuclei are held together by such powerful forces that only most concentrated source of energy like the α-particle is likely to be effective in an attack.

AUTOGENOUS WELDING

Preheating. Preheating in Autogenous Welding (Über das Vorwärmen bei der autogenen Schweissung), Theo. Kautny. Autogene Metallbearbeitung, vol. 15, no. 3, Feb. 1, 1922, pp. 35–39, 8 figs. Advantages of preheating; describes Acme preheater, built by Lausanne Machine Co.

AUTOMOBILE ENGINES

Assembling. Methods Used in the Assembling of 150 Engines per Day, J. Edward Schipper. Automotive Industries, vol. 46, no. 15, Apr. 13, 1922, pp. 818–821, 11 figs. Describes assembling, inspection and testing operations and equipment employed in fabricating powerplant of Jewett car.

Heavy-Oil. A Heavy-Oil Automobile Engine (Un moteur d'automobile a hile lourde). Nature, no. 2499, Feb. 25, 1922, pp. 115–120, 4 figs. Describes the Peugeot engine which operates on kerosene, mazout or vegetable oils and has smaller fuel consumption in addition.

Heavy-Oil. The Peugeot Heavy-Oil Automobile Engine (Der Peugeot-Automobilmotor für Schweröl-betrieb), Lachmann. Motor U. Auto, vol. 19, no. 6, Mar. 31, 1922, pp. 81–86, 4 figs. Can be operated on 400 to 1600 revolutions; is of hot-bulb type; provided with special atomizer giving a perfect mixture.

Manufacture. Manufacturing Practice on Light Motor-car Power Units. Machy. (Lond.), vol. 19, nos. 493, 494 and 496, Mar. 9, 16 and 30, 1922, pp. 685–688, 723–731 and 781–787, 34 figs. Practice of Hotchkiss et Cie, Coventry, in connection with manufacture of 11.9 hp. light car power units for Morris Motors, Ltd., including tooling arrangements, works organization, arrangement of plant, etc.

Oil-Cooled. British Oil-Cooled Car Engines, M. W. Bourdon. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 849–851, 3 figs. Description of oil-cooled engines developed by G. M. Bradshaw, English airplane engine expert. Claimed to have all advantages of air-cooled engine and none of drawbacks.

Stutz. New Stutz Engine More Powerful; Higher Maximum Car Speed. Motor Age, vol. 41, no. 15, Apr. 13, 1922, pp. 16–17, 5 figs. Better handling of fuel, lighter and shorter pistons, better water circulation.

AUTOMOBILE FUELS

Alcohol and Gasoline Mixtures. Using Mixtures of Alcohol and Gasoline in Engines (Note sur l'utilisation, dans les moteurs, des mélanges d'alcool et d'essence), Nicolardot. Technique Automobile et Aérienne, vol. 12, no. 115, 1921 and vol. 13, no. 116, 1922, pp. 116–124 and 18–21, 9 figs. No. 115: Discusses solubility of alcohol in gasoline and experiments made for French war office. No. 116: Gives curve diagrams for solubility limits of alcohol, gasoline, benzol, and explains their application.

Detonation. Detonation—A Consideration of Its Causes, Stanwood W. Sparrow. Automotive Industries, vol. 46, no. 18, May 4, 1922, pp. 951–955, 5 figs. Consideration of tendency of fuel to detonate. Effect of explosion pressure, spark advance and other related factors.

Naphthalene. Hydrated Naphthalene as Automobile Fuel (Hydriertes Naphthalin als Betriebsstoff für Automobile), J. Formánek. Allgemeine Automobil-Zeitung, vol. 23, no. 10, Mar. 11, 1922, pp. 27–29. Describes experiments made which show that tetraline and decaline mixed with benzol and benzene can be used to advantage; tetraline is superior to benzene or benzol.

AUTOMOBILES

Angus-Sanderson 14 Hp. The 14 Hp. Angus-Sanderson Car. Auto, vol. 27, no. 14, Apr. 6, 1922, pp. 283–285, 10 figs. Outstanding features of this London-built vehicle.

Automatic Chassis Lubrication. An Automatic Chassis Lubricating System. Automotive Industries, vol. 46, no. 18, May 4, 1922, pp. 950, 1 fig. New Chalco system does away with oil and grease cups on chassis.

Body Types, Names for. S.A.E. Standard Names for Body Types. Motor Age, vol. 41, no. 18, May 4, 1922, pp. 24–25, 14 figs. S.A.E. committee on body names has reported to parent society and names given have been adopted as standard by that organization.

Diatto 10-Hp. The 10 Hp. Diatto. Auto, vol. 27, no. 13, Mar. 30, 1922, pp. 263–265, 11 figs. Italian car built of British steel and with British body. Engine is of monobloc type with all valves on one side; it has four cylinders, 66-mm. bore, and piston stroke is 90 mm., giving cubic capacity of swept volume of 1017 cc.

Differential, Compensating. A New Type of Compensating Differential. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 857–858, 3 fig. Description of Krohn differential, which allows maximum differential action at low-axle speed and increasing resistance at greater r.p.m.

Dynamometer Test, Rear-Wheel. Rear Wheel Dynamometer Tests and Their Significance to the Engineer, Herbert Chase. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 859–868, 27 figs. Description and data from apparatus in Mason Laboratory, Sheffield Sci. School, Yale Univ. Includes comments on rolling friction, wind resistance, tractive effort, and fuel economy.

Gear Ratio 1914–1922. Rear Axle Gear Ratios of Passenger Cars from 1914 to 1922. Motor Age, vol. 41, no. 18, May 4, 1922, pp. 48–51, 1 fig. Tables of gear ratios for passenger cars by the year.

German Manufacture. The Stoewer Works, Stettin, Germany, and Their Products (Die Stoewer-Werke A.-G. und ihre Erzeugnisse). Motor u. Auto, vol. 19, no. 5, Mar. 15, 1922, pp. 68–72, 8 figs. Products consist of four- and six-cylinder automobiles, motor trucks, tractors and plows. Details of engines, etc.

Light Cars, French. Trend of French Cycle Cars and Light Cars, W. F. Bradley. Automotive Industries, vol. 46, no. 15, Apr. 13, 1922, pp. 801–806, 10 figs. Heavy taxes on automobiles increases interest in cycle cars; tendency toward 4-cylinder water-cooled type, with standard transmission and drive.

Maintenance. Aircraft Maintenance as a Standard for Motor Car Maintenance, P. L. Dumas. Motor Age, vol. 41, no. 14, Apr. 6, 1922, pp. 30–36, 11 figs. Importance of accuracy of tolerances and rigid inspection. Serious consequences of trivial omissions. Function of log book, tolerance sheet and timing disk.

Suspension Springs. Design and Functioning of Laminated Automobile Suspension Springs, A. A. Remington. Automotive Industries, vol. 46, nos. 14 and 15, Apr. 6 and 13, 1922, pp. 757–763 and 807–812, 24 figs. Also Automobile Engr., vol. 12, no. 162, Apr. 1922, pp. 118–127, 24 figs. Apr. 6: Character of laminated springs, and their theoretical and actual functioning; suggestions for improvement in design. Apr. 13: Deals with different spring steels, and gives specifications for standard testing procedure of raw spring material and finished product. Paper, slightly condensed, read before Instn. Automobile Engrs.

A Spring Suspension Which Secures Greater Flexibility. Automotive Industries, vol. 46, no. 18, May 4, 1922, p. 969, 1 fig. In this spring suspension system practically entire sprung weight is supported on two equalizing bars, one at each end of chassis. It is claimed that all rolling is eliminated and afterbounding is damped out.

Transmission Production. An Efficient Method of Transmission Production, J. Edward Schipper. Automotive Industries, vol. 46, no. 16, Apr. 20, 1922, pp. 869–872, 13 figs. Methods employed in Hudson and Essex Transmission Dept. Drilling of cases and machining of gear blanks accomplished by labor-saving methods. Gears matched for best mesh by special testing device.

AVIATION

Aerial Navigation. The Basic Principles of Aerial Navigation (Ueber die Grundlagen der Nautik des Luftmeeres), Conrad Harmsen. Schiffbau, vol. 23, nos. 14, 15, 17 and 18, Jan. 4, 11, 25 and Feb. 1, 1922, pp. 403–408, 435–439, 495–501 and 533–538, 10 figs. Study based on author's experiences during war. Comparison of general nautical and aeronautical principles. Discussion and graphic solution of three most important problems of aerial navigation.

Commercial Airways. The Development of Commercial Airways, Henry White-Smith. Inst. of Transport Jl., vol. 3, no. 3, Mar. 1922, pp. 145–163 and (discussion) 164–170. Summarizes development of air service in Great Britain and other countries and points out some possibilities.

Maps and Navigation. Maps and Navigation Methods, A. Duval. Aerial Age Weekly, vol. 15, no. 9, May 8, 1922, pp. 198–199. International agreement as to maps and merits of flying by compass rather than landmarks. From Preimer Congrès International de la Navigation Aérienne, Nov. 1921.

Sperry Flight Indicator. The Sperry Flight Indicator. Aviation, vol. 12, no. 14, Apr. 3, 1922, pp. 393–394, 1 fig. Describes instrument built for flying in fog and in clouds which combines features of turn indicator and inclinometer.

B

BEAMS

Continuous. Method for Calculating Lines of Influence of Bending Moments of Continuous Beams (Verfahren zur Ermittlung von Einflusslinien der Biegungsmomente durchlaufender Träger), H. Kayser. Beton u. Eisen, vol. 21, no. 4, Feb. 23, 1922, pp. 56–60, 12 figs. Describes simple method of calculating lines of influence for beams with unsymmetrical opening having no particular ratio to one another and for varying moments of inertia.

T-Shaped Cross-Sections. Method for Measuring T-Shaped Cross-Sections (Bemessungsverfahren für T-förmigen Querschnitt), Franz Kardos Beton u. Eisen, vol. 21, no. 4, Feb. 23, 1922, pp. 62–65, 4 figs. Presents chart for measurement of T-shaped cross-sections and describes its applications.

BEARING METALS

Babbitt, Pouring Temperature for. Definite Temperature Control Necessary in Babbitt Pouring, Karl F. Smith. Elec. World, vol. 79, no. 18, May 6, 1922, pp. 886–887. Challenge of article on "Suggestions on Rebabbitting Bearings," by M. M. Brown, p. 434 of Elec. World, Mar. 4.

BEARINGS

Frictional Resistance of Lubricated. The Synthetic Calculation of Frictional Resistances of Lubricated Bearings (Die synthetische Berechnung der Reibungswiderstände geschmierter Lager, Etc.), W. v. Dallwitz-Wegner. Zeit. für technische Physik, vol. 3, no. 1, 1922, pp. 21–28, 8 figs. Calculation to determine properties of lubricating oil, based on internal friction of lubricating oil and capillary properties of oil and bearing metal.

Unsymmetrical. Pressures in Unsymmetrical Bearings, A. W. Knight. Machy. (Lond.), vol. 19, no. 496, Mar. 30, 1922, pp. 789–790, 2 figs. Makes calculations from which it is concluded that it is bad practice to use unsymmetrical bearings of whatever proportions.

BEARINGS, ROLLER

Railway Motors. Roller Bearings for Railway Motors (Wälzlager für Bahnmotoren), H. Mecke.

Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 12, Mar. 25, 1922, pp. 269–274, 23 figs. Notes on first experiments with ball bearings; ball and roller bearings for railway motors and advantages of latter.

BELTING

Care and Splicing. Splicing and Care of Leather, Rubber and Canvas Belts, G. H. Radebaugh. Coal Age, vol. 21, no. 17, Apr. 27, 1922, pp. 687–690, 25 figs. Oak-tanned leather preferable for power transmission; why short-lap belt is recommended; tallow and cod-liver oil make good dressing; cement, wire and rawhide fastenings.

Leather. Leather Belt Research Conclusions, J. Edgar Rhoads. Can. Mfr., vol. 42, no. 4, Apr. 1922, pp. 25–26. Manufacturers have conducted investigations into various phases of uses of leather belting, results of which are outlined.

V-Type. New Belt That May Revolutionize Drives to Light Machinery, Roger Fison. Belting, vol. 20, no. 4, Apr. 1922, pp. 26–28, 1 fig. Due to greater friction surface and flexiblity this type can transmit much greater power under less tension than round belt. Hints on other sizes.

Widths, Relative Capacity. Relative Capacity of Leather Belts of Different Widths. Belting, vol. 20, no. 4, Apr. 1922, pp. 36–38, 1 fig. Experiments by R. S. Jones of Leather Belting Exchange Foundation, Cornell Univ. Power transmitted increased from 22 at end of 9 hr. to 57 at end of 47½ hr. Capacity apparently varies directly with width.

BLAST-FURNACE GAS.

Cleaning. Economy of Modern Blast-Furnace-Gas Cleaning Processes in the Rhur and Minette Districts (Wirtschaftlichkeit neuzeitlicher Hochofengasreinigungen im Ruhr- und Minettebezirk), Max Schlipköter. Stahl u. Eisen, vol. 42, nos. 8 and 11, Feb. 23 and Mar. 16, 1922, pp. 285–290 and 408–422, 4 figs. 1 on supp. plate. Advantages of use of well-purified gases in air heating. Influence of water content of gases. Requirements of blast-furnace gas for economical operation. Determination of operating costs of cleaned gases based on practical examples with different cleaning processes. Advantages of dry filter process.

BLAST FURNACES

Oxygen Admixture to Air. The Admixture of Oxygen to Blast in Blast-Furnace Plants (Verwendungsmöglichkeiten der Lindeluft in Hochofenbetrieben), Theodor Wagner. Stahl u. Eisen, vol. 42, no. 12, Mar. 23, 1922, pp. 456–460. Notes on earlier opinions and experiments; changed conditions in blast-furnace practice since war; reduction of coke charge and introduction of producer gas or pulverized coal through tuyeres; use of air rich in oxygen in blast furnaces with pulverized-coal heating.

BOILER FEEDWATER

Preheating. Preheating of Locomotive Feedwater (Les réchauffeurs de l'eau d'alimentation des locomotives). Génie Civil, vol. 80, no. 14, Apr. 8, 1922, 320–324, 8 figs. Compares open and closed types and discusses American practice.

Regulator, Automatic. Hydraulic Feed-Water Automatic Regulator. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 169. Some features of new Aster-Anthony hydraulic feedwater regulator.

Self-Cleaning Evaporator Coils. Self Cleaning Evaporator Coils. Am. Mar. Engr., vol. 17, no. 5, May 1922, p. 33. Reilly evaporator, submerged type, self-scaling coil solved problem of accumulation of salt scale.

Treatment of Water. Boiler Water, C. E. Joos and A. W. Binns. Power Plant Eng., vol. 26, nos. 9 and 10, May 1 and 15, 1922, pp. 456–460 and 511–514, 23 figs. May 1: Up-to-date methods of eliminating impurities which cause trouble in boilers. May 15: Priming, its causes and their relative importance; continuous determination of steam quality.

BOILER FIRING

Brown Coal. Boiler Firing with Brown Coal (Feuerungsanlagen für Rohbraunkohlen), O. Binder. Wärme- u. Kälte-Technik, vol. 24, no. 6, Mar. 15, 1922, pp. 65–67, 4 figs. Suitable firebox and grate arrangements; mechanical stoking; etc.

Peat. Firing Peat Under Boilers with Inclined Grate and Automatic Stoking (Die Verfeuerung von Torf in einer Schrätiger Beschickung unter Luftabschluss), W. Ledler. Wärme, vol. 45, no. 10, Mar. 10, 1922, pp. 121–124, 2 figs. Describes furnace built by Varel Iron Wks., near Oldenburg, and gives results of number of evaporation tests.

Pure and Mixed Peat Fuel for Boiler Firing (Reine und gemischte Torffeuerung in Dampfkesselfeuerungen). Rauch u. Staub, vol. 12, no. 6, Mar. 1922, pp. 53–56. Adaptation of firebox conditions to burning of peat, and advantages of peat in firing with brown coal and other low-grade fuels.

BOILER OPERATION

Load Indicators. Indicating Station Load in the Boiler Room, F. F. Leilich. Power, vol. 55, no. 15, Apr. 11, 1922, pp. 579–580, 4 figs. Automatic load indicator is described which has made it possible to hold steam pressures within prescribed limits under fluctuating loads and practically to prevent safety valves popping off.

Sugar Factories. Boiler House Operation in Sugar Factories (Kesselhauswirtschaft in Zuckerfabriken), H. Berner. Wärme, vol. 45, no. 3, Jan. 20, 1922, pp. 41–47, 11 figs. Deals with inherent difficulties in sugar factories; advantage of high boiler pressure; heat storage; saving of fuel through use of heating-gas preheater; high-pressure economizers, also for low-pressure boilers; forced-draft installations; practical tests on gas losses in anthracite furnaces; efficiency of the Eimert boiler-tube nests.

BOILERS

Cleaning. Cleaning Boilers by Means of Sand-Blast Apparatus (Reinigung von Dampfkesseln durch Sandstrahlgebläse), W. Kaempfer. Technische Blätter, vol. 12, no. 15, Apr. 14, 1922, pp. 153–154, 6 figs. Describes various experiences, especially with cleaning locomotive boilers; process requires about 200 kg. of sand per hr.

Furnace. See FURNACES, BOILER.

Locomotive. See LOCOMOTIVE BOILERS.

Marine. See MARINE BOILERS.

Settings. Progress in Boiler Setting (Fortschritte auf dem Gebiete der Dampfkesseleinmauerung), W. Ritter. Feuerungstechnik, vol. 10, no. 12, Mar. 15, 1922, pp. 125–126. Describes innovations in boiler brickwork.

Upkeep of Idle. Upkeep of Idle Boilers (La conservation des chaudieres en chomage), V. Kammerer. Bul. des Associations Françaises de Propriétaires d'Appareils a Vapeur, no. 3, Jan. 1921, pp. 133–138. Precautionary measures to keep out rust, contact with air or water, etc.

BOILERS, WATER-TUBE

Marine. A New American Water-Tube Boiler for Capital Ships. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 150–153 and 154–155, 2 figs. Features of experimental boiler designed by Rear-Admiral Dyson, U. S. N. and tested by Phila. Navy Yard.

BRAKES

Freight-Train, French. The Question of Continuous Brakes in the French Freight Trains (Die Frage der durchlaufenden Bremse für Güterzüge in Frankreich), H. Pechot. Organ für die Fortschritte des Eisenbahnwesens, vol. 77, no. 2, Jan. 15, 1922, pp. 17–22. Discusses experiments with air and vacuum brakes on French railways; also the Clayton Hardy, Kunze-Knorr, Westinghouse, and other brakes. Pp. 22–25, criticism by A. Führ.

BRASS

Cold Strip Rolling. American Practice in Cold Rolling Brass Strip, C. E. Davies. Metal Industry (Lond.), vol. 20, no. 13, Mar. 31, 1922, pp. 293–297, 2 figs. Points out that main points of difference in American from English practice are (1) machining or overhauling cast ingot before rolling; (2) increased rolling speeds; and (3) improved methods and appliances for handling and cleaning metal.

BROACHES

Pull. The Design of Pull Broaches. Machy. (Lond.), vol. 20, no. 497, Apr. 6, 1922, pp. 13–15, 4 figs. Depth of cut; pitch of teeth; length; shape of teeth; methods of attaching broaches to machines.

BRONZES

Cast, Analysis of. Notes on the Analysis of Cast Bronze, G. E. F. Lundell and J. A. Scherrer. Jl. of Indus. & Eng. Chem., vol. 14, no. 5, May 1922, pp. 426–429. Desirable procedures and precautions often ignored. Based on work done at Bur. of Stand. and by coöperating analysts.

BUSES

Gasoline-Electric, England. Gasoline-Electric Bus with Unusual Features Operated in England. Bus Transportation, vol. 1, no. 5, May 1922, pp. 283–284, 2 figs. Description of type carrying gasoline engine, dynamo and electric motor.

C

CABLEWAYS

Aerial Passenger. Suspended Railways for Passenger Service in Comparison with Surface Mountain Railways (Drahtseilschwebebahnen zur Beförderung von Personen im Vergleich zu ebenerdigen Bergbahnen), H. Gatzweiler. Verkehrstechnik, vol. 39, no. 12, Mar. 24, 1922, pp. 142–145, 3 figs. Describes Bleichert system of suspended cableway and points out advantages of such systems.

CALORIMETERS

Continuous-Flow. A Continuous-Flow Calorimeter, and the Determination of the Heat of Neutralization of a Solution of Hydrochloric Acid by one of Sodium Hydroxide, Frederick G. Keyes, Louis J. Gillespie and Shinroku Mitsukuri. Am. Chem. Soc. Jl., vol. 44, no. 4, Apr. 1922, pp. 707–717, 3 figs. Describes experiments carried out and apparatus used.

CALORIMETRY

Bomb Corrosion. The Effect of Bomb Corrosion on the Accuracy of Calorimetric Determinations, H. L. Olin and R. E. Wilkin. Chem. & Met. Eng., vol. 26, no. 15, Apr. 12, 1922, pp. 694–696. Describes experiments made with nickel-lined bombs.

CAMS

Calculation Calculation of Cams (Calcul des cames), Octave Lepersonne. Technique Automobile et Aerienne, vol. 12, nos. 113 and 114, 1921, pp. 33–42 and 68–71, 15 figs. No. 113: Discusses theory, determination of geometric form, application of straight line and arc profiles. No. 114: Graphic calculation and numerical examples.

CARS

Design Problems. Springs, Draft Gears and Other Problems in Car Design, Louis E. Endsley. Ry. Rev., vol. 70, no. 17, Apr. 29, 1922, pp. 591–594, 3 figs. Shorter spring travel and longer draft-gear travel suggested as solution to most serious problem. Address before Virginia Section of A.S.M.E.

Restaurant and Sleeping. Restaurant and Sleeping Cars for the Siamese State Railways. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, pp. 554–556, 11 figs. partly on pp. 559–560. Designed to afford maximum comfort to travelers; workmanship of highest class.

CAST IRON

Early History. The Early History of Iron with Special Reference to Cast Iron, J. Newton Friend. Foundry Trade Jl., vol. 25, nos. 290, 291 and 292, Mar. 9, 16 and 23, 1922, pp. 182–183, 193–194 and 216–218, 9 figs. Discusses iron in Egypt and Palestine, Mesopotamia, Europe, Great Britain and Central Africa; direct reduction of iron ores; reduction of iron in Africa; discovery of cast iron; 18th century developments.

Mechanical Tests. Mechanical Tests of Cast Iron (Considérations générales sur les essais mécaniques des fontes), M. Portevin. Révue Universelle des Mines, vol. 12, no. 6, Mar. 15, 1922, pp. 507–511. Discusses the various tests available and shows that some, such as the impact test, are of no value. Recommends tensile strength and Brinell tests.

CEMENT

Canadian Specifications. New Cement Specifications, Canadian Engineering Standards Association. Can. Engr., vol. 42, no. 17, Apr. 25, 1922, pp. 428–429. Résumé of new report from Can. Standards Assn. based also on specifications of Eng. Inst. of Canada, Am. Soc. for Testing Matls., and Brit. Standards for Portland Cement.

Fused. Fused Cement (Le Ciment fondu). Vie Technique et Industrielle, vol. 3, no. 30, Mar. 1922, pp. 503–506, 4 figs. Discusses French process for making cement containing 10 per cent silica, 40 alumina, 10 iron oxide, 40 lime, raised to temperature of complete fusion, and its properties and characteristics.

Hardening. Experiments on the Effect of Low Temperatures on the Hardening of Cement (Versuche über die Einwirkung von niedrigen Temperaturen auf das Erhärten des Zements), H. Kreüger. Beton u. Eisen, vol. 21, no. 5, Mar. 18, 1922, pp. 74–78, 4 figs. Discusses tests with cement cubes to show effect of freezing temperature and draws number of conclusions.

CENTRAL STATIONS

Heating and Power. Investigating the Efficiency of a Central Heating and Power Station (Wirtschaftliche Untersuchungen an einem Fern-Wärmekraftwerk), M. A. Nüscheler. Gesundheits-Ingenieur, vol. 45, no. 13, Apr. 1, 1922, pp. 169–177, 5 figs. Author's experience in construction and operation of steam piping for central heating stations, either in connection with central power stations or without it.

Superpower. Superpower System for Japan, C. A. Powel. Elec. Rec., vol. 31, no. 5, May 1922, pp. 357–359, 1 fig. Program for furnishing electricity over large area between Tokio and Osaka.

Hoover Sees Super-Power Project as Possible Stabilizer of Coal Industry. Min. Congress Jl., vol. 8, no. 5, May 1922, pp. 729–730. Theory that project in Atlantic Coast region between Washington, D. C. and Portland, Me., might stabilize coal industry.

CHIMNEYS

Heat Losses in. The Relation Between CO_2 and Stack Losses. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 429–431, 3 figs. Discusses various factors governing chimney loss, and shows that the magnitude of chimney loss bears definite relation to percentage of CO_2 in flue gases.

CLUTCHES

Magnetic. Magnetic Clutches in the Cement Industry, W. H. Costello. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 5, May 1922, pp. 361–363, 2 figs. Clutch requirements and description of magnetic type which meets them.

Systems. Study of the Various Clutch Systems (Étude des divers systèmes d'embrayages), Henri Petit. Technique Automobile et Aerienne, vol. 13, no. 116, 1922, pp. 4–17, 28 figs. Describes English and American gear systems for automobiles, including cone clutches and disk clutches, and gives tabulated statement of their characteristics.

COAL

Analysis. Coal Analyses May Be Misleading Because of Crude and Insufficient Sampling, O. P. Hood. Coal Age, vol. 21, no. 12, Mar. 23, 1922, pp. 484–486. Advises averaging of numerous samples taken over long period to get representative value. Based on address before Nat. Assn. Purchasing Agents.

Coking Propensities. The Coking Propensities of Coals, W. A. Bone, A. R. Pearson, E. Sinkinson, W. E. Stockings. Gas World, vol. 76, no. 1967, Apr. 1, 1922, pp. 16–20, 1 fig. Results of experimental investigations into resinic constituents of bituminous coals and their supposed determining influence upon coking propensities of coals. (Abstract.) Paper read before Royal Soc.

Combustion. Combustion of Coal, R. B. MacMullin. Combustion, vol. 6, no. 3, Mar. 1922, pp. 118–123, 5 figs. Composition and classification of coal; oxidation of carbon.

Recovery from Ashes of Coke and. Recovery of Coke and Coal From Ashes (Rückgewinnung von Koks und Kohlen aus Asche), Ullrich. Montanistische Rundschau, vol. 14, nos. 3 and 7, Feb. 1 and Apr. 1, 1922, pp. 56–58 and 153–156, 7 figs. Describes electromagnetic ash separators and shaking tables, and gives results of some experiments with ashes from anthracite firing at experiment station of Krupp-Gruson works.

Sampling. Sampling Fuel (Prélèvement et préparation d'un échantillon moyen de combustibles). Bul. des Associations Françaises de Propriétaires d'Appareils à Vapeur, no. 6, Oct. 1921, pp. 330–331, 1 fig. Procedure adopted by French associations for drawing and preparing average sample of coal.

COAL GAS

Economical Use. Economical Use of Illuminating Gas (L'emploi economique du gaz d'eclairage), R. Villers. Nature, no. 2500, Mar. 4, 1922, pp. 134–138, 7 figs. Various uses of the gas; types of burners; proper mixing with air; compressing.

COAL HANDLING

Bunkering Cranes. Recent Developments in Bunkering Cranes, Cargo, Coal Loading Equipment and Shipbuilding Cranes, Justin Griess. World Ports, vol. 10, no. 6, Apr. 1922, pp. 47–55. Describes methods for bunkering coal at various harbors.

Equipment. Coal and Ash-Handling Equipment, Harry R. Westcott. Steam, vol. 29, no. 4, Apr. 1922, pp. 93–100. Description of various units from yard storage through traveling bridges, feeders, chain elevators and conveyors to ash hoppers.

COAL STORAGE

Methods. Coal Storage (La conservation des charbons), E. Schmidt. Bul. des Associations Françaises de Propriétaires d'Appareils à Vapeur, no. 4, Apr. 1921, pp. 165–181. Discusses change in coal exposed to air, spontaneous combustion, storage under water, coal piles, etc.

COKE BREEZE

Steam Generation. The Utilization of Coke Breeze for the Generation of Steam, W. Francis Goodrich. Gas Engr., vol. 38, no. 550, Feb. 15, 1922, pp. 44–46. Features of this fuel which make it of real value.

COLD STORAGE

Indirect Air Cooling. Indirect Air Cooling for Cold Storage—A Problem in Design, H. E. Corl. Refrigeration, vol. 29, no. 8, Mar. 1922, pp. 26–28, 1 fig. Considerations necessary in design; refrigeration; bunker coil surfaces; selection of fan and motor; thermostatic control of temperature.

COMBUSTION

Coal. Combustion of Coal, R. B. MacMullin. Combustion, vol. 6, no. 5, May 1922, pp. 224–228, 4 figs. Relation between temperature, excess air, and rate of combustion.

COMPRESSED AIR

Mines. Determining the Drop in Pressure in Compressed Air Piping in Mines (Ermittlung des Druckabfalls in Pressluftleitungen untertage), W. Reinhard. Glückauf, vol. 58, no. 15, Apr. 15, 1922, pp. 433–436, 1 fig. Discusses drop due to pipe resistance, and gives chart from which average loss of head can be calculated.

CONDENSERS, STEAM

Steam. Season Cracking in Condenser Tubes. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 461–462, 6 fig. Cracking of tubes. Study of costs and suggestions toward elimination.

CONVEYORS

Belt. Biggest Belt-Conveyor System in the World, D. R. Egbert. Belting, vol. 20, no. 4, Apr. 1922, pp. 17–25, 5 figs. Parcel-post station in Chicago to be completed June 1922, will have 8 miles canvas-stitched belting. Description of installation, largest in world.

Monorail. Monorail Conveyors on Clay Plants. Brick and Clay Rec., vol. 60, no. 8, Apr. 18, 1922, pp. 613–615, 9 figs. This type desirable for clay plants. Description of installations at R. Thomas & Sons, East Liverpool, Ohio, and Brooklyn (Ind.) Brick Co.

Steel-Belt. Flexible Steel Belt Conveyors, Harry Carlson. Gas Age-Rec., vol. 49, no. 13, Apr. 1, 1922, pp. 383–385, 6 figs. Describes steel belt made by Sandviken Steel Works, Sweden, and gives particulars as to strength, corrosion, loading width, etc.

Steel-Band Conveyors. Eng. Progress, vol. 3, no. 5, May 1922, pp. 109–110, 13 figs. Application and advantages of steel-band conveyors of Sandviken type.

Telphers vs. Telphers vs. Conveyors for Gas Works Purposes, Herbert Blyth. Gas. Engr., vol. 38, no. 549, Jan. 16, 1922, pp. 6–7, 2 figs. Features of gas manufacturing plant and comparative advantages of overhead telphers and conveyor systems.

COOLING TOWERS

Recooling of Water in. Recooling Plants (Ueber Rückkühlanlagen), Fritz Hoyer. Wärme, vol. 45, no. 6, Feb. 10, 1922, pp. 77–80, 7 figs. Desiderata for obtaining good results from cooling installations. Details and advantages of modern types.

CORROSION

Colloids, Influence of Protective. The Influence of Protective Colloids on the Corrosion of Metals and on the Velocity of Chemical and Physical Change, John A. N. Friend and Reece H. Vallance. Chem. Soc. Jl., vol. 121–122, no. 713, Mar. 1922, pp. 466–474, 2 figs. Concludes that after a general law protective colloids tend to retard velocity of such reactions as involve change of state from solid to liquid, or vice versa, in one or more of the components.

Ferrous Metals. Corrosion of Ferrous Metals, Robert Abbott Hadfield. Metal Industry (Lond.), vol. 20, no. 16, Apr. 21, 1922, pp. 381–382. Preparation of various ferrous metals used in corrosion research of Inst. Civil Engrs. together with their physical and mechanical properties and some general considerations on subject of corrosion. (Abstract.) Paper read before Inst. Civil Engrs.

Rust Prevention. The Prevention of Rust. Motor Transport, vol. 34, no. 896, May 1, 1922, p. 529, 1 fig. Notes on application of thermozine process for protecting certain parts of motor vehicles against corrosion.

Oxidization Prevention. Calorizing and Calite, G. H. Howe and G. R. Brophy. Gen. Elec. Rev., vol. 25, no. 5, May 1922, pp. 267–272, 5 figs. Description of process developed in Schenectady Research Laboratory to prevent corrosion.

COST ACCOUNTING

Depreciation and Retirement of Property. Depreciation and Retirement of Property, William H. Bell. Jl. of Accountancy, vol. 33, no. 4, Apr. 1922, pp. 253–258. Shows that where average rate of depreciation is used, if a unit of property is retired in advance of average estimated life of all units in its class, entire cost of unit retired should be charged to reserve for depreciation.

Engineering Methods Applied to. Engineering Methods Applied to Cost Finding, Robert S. Denham. Indus. Management, vol. 63, nos. 2, 3, 4 and 5, Feb., Mar., Apr. and May, 1922, pp. 67–73, 161–166, 218–220, and 310–312, 4 figs. Feb.: Effect upon profit margin of traditional and misleading cost methods. Mar.: General principles underlying application of expense items. Apr.: Six fundamental principles of cost engineering. May: Definite procedure for surveying the requirements of production.

Factory. Factory Accounts, Costs, and Statistics, R. Dunkerley. Foundry Trade Jl., vol. 25, nos. 293 and 294, Mar. 30 and Apr. 6, 1922, pp. 233–235 and 248–249. Comparative factory expenses; underlying principles and essential details; foundry tackle; monthly statements; individual costs; overhead charges; wasters; etc.

New Plan. Cost Accounting, Guy Foote Wetzel. Armour Engr., vol. 13, no. 3, Mar. 1922, pp. 163–174. Discusses cost accounting plan with some new features, by A. W. Torbet, installed in large manufacturing plant, and compares with usual methods.

Scientific, Necessity for. Costing in Industry. Eng. & Indus. Management, vol. 7, no. 12, Apr. 20, 1922, pp. 357–360. First part of special report of Costing Conference held in Lond., covering cost accountant's position, works expenditure, periodical comparisons, and productive labor.

COTTON INDUSTRY

Electrical Equipment. The Electrical Equipment of the D. R. Cotton Mills. Electrician, vol. 88, no. 2292, Apr. 21, 1922, pp. 473–474, 4 figs. Some details of mills which contain both spinning and weaving sections.

CRANES

Classification. Classification of Hoisting Machines Particularly Cranes (Einteilung der Hebe- und Transportmaschinen, insbesondere der Krane), R. Dub. Fördertechnik u. Frachtverkehr, vol. 15, nos. 1 and 2, Jan. 6 and 20, 1922, pp. 1–4 and 22–26, 59 figs. Classification of the various types of cranes into groups according to their kinematic characteristics, assuming that load is always concentrated at center of gravity.

Floating. A 60-ton Floating Crane, W. Fox. Mech. World, vol. 71, nos. 1837 and 1838, Mar. 17 and 24, 1922, pp. 207–209 and 224–226, 10 figs. Describes in detail revolving jib type floating crane, built by Werf Gusto (Firma A. F. Smulders), Schiedan, Holland.

Inspection. Things that the Crane Inspector Looks for and Some of the Hows and Whys, A. L. Gear. Elec. Rev. & Indus. Engr., vol. 80, no. , Mar. 1922, pp. 111–118, 152, 1[illegible] figs. Inspection report forms and things looked for in making inspection

Wrecking. Ten-Ton Locomotive Steam Breakdown Crane. Engineer, vol. 133, no. 3457, Mar. 31, 1922, p. 357, 3 figs. partly on p. 360. Built by Bedford Engineering Co., Bedford, England, for Great Western of Brazil Ry., and designed to lift loads up to 10 tons at radius of 20 ft.

CRANKSHAFTS

Steel for. Steel for Crankshafts: Its Heat Treatment, H. C. Loudenbeck. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 181–183. Grades of steel that are being used for this purpose, and their heat treatment and physical properties to secure best results.

CUPOLAS

Charging Elevator, Combined with. An Improved Foundry Melting Plant. Engineer, vol. 133, no. 3457, Mar. 31, 1922, pp. 365–366, 3 figs. Describes plant designed by J. E. Hurst for regular production of high-grade cast iron for use in manufacture of castings by centrifugal-casting process. Consists of a cupola, an elevator charging arrangement and an oil-fired receiver.

Design and Operation. Iron and Foundry Cupola Management, J. J. McClelland. Foundry Trade Jl., vol. 25, no. 292, Mar. 23, 1922, pp. 209–213, 5 figs. Author's experience in cupola practice; describes layout of plant, construction of cupola, linings, charging, fans or blowers, etc. Paper read before Instn. British Foundrymen.

Iron Melting. Cupola Practice, J. Wood. Foundry Trade Jl., vol. 25, nos. 296 and 297, Apr. 20 and 27, 1922, pp. 288–290 and 304–306, 3 figs. Some difficulties that have to be overcome in melting iron by cupola process which, for quickness and cheapness, is not excelled by any other furnace. Details of lining and tuyeres. Paper read before Instn. British Foundrymen.

D

DIESEL ENGINES

Flexibility. Diesel Engine Flexibility, W. S. Burn. Steamship, vol. 33, no. 394, Apr. 1922, pp. 320–331, 9 figs. Investigation with view to its application to direct-driven Diesel locomotive. It is shown that principles governing flexibility are practically identical with those governing economy. Read before Graduate Section of North-East Coast Instn. Engrs. & Shipbuilders.

Generator Drive. Oil-Engine-Driven Ship Generators in the German Navy (Der ölmotorische Antrieb von Borddynamos in der deutschen Kriegsmarine), W. Laudahn. Schiffbau, vol. 23, nos. 13, 14, 15, 16, 19–20, 21, 23 and 25–26, Dec. 28, 1921, and Jan. 4, 11, 18, Feb. 8–15, 22, Mar. 15 and 22–29, 1922, pp. 363–369, 397–403, 429–435, 467–470, 565–573, 605–614, 745–752 and 777–780, 93 figs. Dec. 28: The 300-kw. Diesel engine built by Körting Bros., Inc., for liner, König. Jan. 4: Engine of Fried. Krupp Corp. Germania Shipyard for liner Kronprinz. Jan. 11 and 18: Engine of Benz & Co., Mannheim, for liner Bayern. Feb. 8: Engine of Vulcan Works, Inc., Hamburg for liner Württemberg. Feb. 22: Engine of Augsburg-Nürnberg Corp. for large cruiser. Lützow. Mar. 15 and 22: Engine of Görlitzer Machine Constr. & Iron Foundry Corp. for large cruiser Hindenburg.

Heavy and Low-Grade Oil. Using Heavy and Low Grade Oil in Motors of the Diesel Type (Mineria y Petróleo), Benigno Benigni. Ingenieria, vol. 26, no. 3, Mar. 1922, pp. 133–135, 1 fig. Some experiments with Ansaldo San Giorgio engines running on cotton-seed and palm oils.

Lighter. Use Diesel Unit for Lighter. Mar. Rev., vol. 52, no. 5, May 1922, pp. 215–217, 3 figs. Installation of unit on derrick lighter Worthington, owned by Worthington, Pump & Machy. Corp. develops 300 b.hp. at 275 r.p.m.

Locomotive. Industrial and Scientific Progress. Beama, vol. 10, no. 4, Apr. 1922, pp. 295–298. Description of air auxiliary cylinders with Diesel engine which give sufficient flexibility for use on locomotives; designed by W. S. Burn who presented paper on subject before N. E. Coast Instn. Engrs. & Shipbuilders.

Marine. A 1000-Hp. Marine Diesel Engine of the German Works, Inc. (Ein 1000 PS-Schiffs-Dieselmotor der Deutschen Werke A.-G.), P. Stephan. Motor u. Auto, vol. 19, no. 5, Mar. 15, 1922, pp. 65–68, 2 figs. Also Schiffbau, vol. 23, no. 27, Apr. 5, 1922, pp. 815–824. Describes engine recently completed in Kiel shipyard which is one of two engines to be installed in a tanker with 8000-ton displacement built for the Italian Government. It is 6.6 m. high and has six 4-stroke single-acting cylinders.

Injection and Combustion of Fuel-Oil—IX, C. J. Hawkes. Motorship, vol. 7, no. 5, May 1922, pp. 366–367, 4 figs. Experiments with solid-injection and air-blast in marine Diesel engines. (Concluded.)

The Beardmore-Tosi Diesel Engine. Steamship, vol. 33, no. 394, Apr. 1922, pp. 332–338, 9 figs. Presents table showing relative cost of fuel, oil, and personnel for two types of vessels, one steam-driven and the other Diesel-driven. Details of Beardmore-Tosi marine engines.

DRAFT

Equalized. The Significance of Equalized Draft (Wesen und Bedeutung des ausgeglichenen Zuges), Hch. Doevenspeck. Wärme, vol. 45, no. 9, Mar. 3, 1922, pp. 111–113, 2 figs. Discusses questions relating to natural and forced draft and advantages of equalized draft.

DRILLING MACHINES

Pneumatic. Pneumatic Drilling Machines and Hammers in Mining and Related Industries (Druckluft-Bohrmaschinen und -Hammer im Bergbau und in den verwandten Betrieben), R. Goetze. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 11 and 12, Mar. 18 and 25, 1922, pp. 245–251 and 278–280, 42 figs. History of development and description of most important modern types of drilling machines, hammers and picks. Prospects of future development.

DROP FORGINGS

Difficulties. How Drop Forgings are Made Perfect, J. H. G. Williams. Raw Material, vol. 5, no. 4, May 1922, pp. 140–143, 14 figs. Summarizes chief difficulties in production of faultless drop forgings. Paper presented at N. Y. Sectional Meeting of Am. Soc. for Steel Treating.

Modern Practice. Modern Drop-Forging Practice—II. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 508–511, 7 figs. Deals with trimming of forgings and correct forging heats, and gives typical examples of drop-forging work.

DRYING

Wood. Note on Drying (Note sur le séchage), P. Villain. Révue de l'Industrie Minérale, no. 31, Apr. 1, 1922, pp. 155–170, 10 figs. General principles of drying methods as applied in mining and metallurgy, especially of woods.

DURALUMIN

Properties and Commercial Possibilities. Duralumin Properties and Commercial Possibilities. Brass World, vol. 18, no. 4, Apr. 1922, pp. 129–130. Characteristics of this material, one-third the weight of cold-rolled steel though with same approximate strength.

Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 12, Mar. 25, 1922, pp. 269–274, 23 figs. Notes on first experiments with ball bearings; ball and roller bearings for railway motors and advantages of latter.

BELTING

Care and Splicing. Splicing and Care of Leather, Rubber and Canvas Belts, G. H. Radebaugh. Coal Age, vol. 21, no. 17, Apr. 27, 1922, pp. 687–690, 25 figs. Oak-tanned leather preferable for power transmission; why short-lap belt is recommended; tallow and cod-liver oil make good dressing; cement, wire and rawhide fastenings.

Leather. Leather Belt Research Conclusions, J. Edgar Rhoads. Can. Mfr., vol. 42, no. 4, Apr. 1922, pp. 25–26. Manufacturers have conducted investigations into various phases of uses of leather belting, results of which are outlined.

V-Type. New Belt That May Revolutionize Drives to Light Machinery, Roger Fison. Belting, vol. 20, no. 4, Apr. 1922, pp. 26–28, 1 fig. Due to greater friction surface and flexiblity this type can transmit much greater power under less tension than round belt. Hints on other sizes.

Widths, Relative Capacity. Relative Capacity of Leather Belts of Different Widths. Belting, vol. 20, no. 4, Apr. 1922, pp. 36–38, 1 fig. Experiments by R. S. Jones of Leather Belting Exchange Foundation, Cornell Univ. Power transmitted increased from 22 at end of 9 hr. to 57 at end of 47½ hr. Capacity apparently varies directly with width.

BLAST-FURNACE GAS.

Cleaning. Economy of Modern Blast-Furnace-Gas Cleaning Processes in the Rhur and Minette Districts (Wirtschaftlichkeit neuzeitlicher Hochofengasreinigungen im Ruhr- und Minettebezirk), Max Schlipköter. Stahl u. Eisen, vol. 42, nos. 8 and 11, Feb. 23 and Mar. 16, 1922, pp. 285–290 and 408–422, 4 figs. 1 on supp. plate. Advantages of use of well-purified gases in air heating. Influence of water content of gases. Requirements of blast-furnace gas for economical operation. Determination of operating costs of cleaned gases based on practical examples with different cleaning processes. Advantages of dry filter process.

BLAST FURNACES

Oxygen Admixture to Air. The Admixture of Oxygen to Blast in Blast-Furnace Plants (Verwendungsmöglichkeiten der Lindeluft in Hochofenbetrieben), Theodor Wagner. Stahl u. Eisen, vol. 42, no. 12, Mar. 23, 1922, pp. 456–460. Notes on earlier opinions and experiments; changed conditions in blast-furnace practice since war; reduction of coke charge and introduction of producer gas or pulverized coal through tuyeres; use of air rich in oxygen in blast furnaces with pulverized-coal heating.

BOILER FEEDWATER

Preheating. Preheating of Locomotive Feedwater (Les réchauffeurs de l'eau d'alimentation des locomotives). Génie Civil, vol. 80, no. 14, Apr. 8, 1922, 320–324, 8 figs. Compares open and closed types and discusses American practice.

Regulator, Automatic. Hydraulic Feed-Water Automatic Regulator. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 169. Some features of new Aster-Anthony hydraulic feedwater regulator.

Self-Cleaning Evaporator Coils. Self Cleaning Evaporator Coils. Am. Mar. Engr., vol. 17, no. 5, May 1922, p. 33. Reilly evaporator, submerged type, self-scaling coil solved problem of accumulation of salt scale.

Treatment of Water. Boiler Water, C. E. Joos and A. W. Binns. Power Plant Eng., vol. 26, nos. 9 and 10, May 1 and 15, 1922, pp. 456–460 and 511–514, 23 figs. May 1: Up-to-date methods of eliminating impurities which cause trouble in boilers. May 15: Priming, its causes and their relative importance; continuous determination of steam quality.

BOILER FIRING

Brown Coal. Boiler Firing with Brown Coal (Feuerungsanlagen für Rohbraunkohlen), O. Binder. Wärme- u. Kälte-Technik, vol. 24, no. 6, Mar. 15, 1922, pp. 65–67, 4 figs. Suitable firebox and grate arrangements; mechanical stoking; etc.

Peat. Firing Peat Under Boilers with Inclined Grate and Automatic Stoking (Die Verfeuerung von Torf in einer Schrätiger Beschickung unter Luftabschluss), W. Ledler. Wärme, vol. 45, no. 10, Mar. 10, 1922, pp. 121–124, 2 figs. Describes furnace built by Varel Iron Wks., near Oldenburg, and gives results of number of evaporation tests.

Pure and Mixed Peat Fuel for Boiler Firing (Reine und gemischte Torffeuerung in Dampfkesselfeuerungen), Rauch u. Staub, vol. 12, no. 6, Mar. 1922, pp. 53–56. Adaptation of firebox conditions to burning of peat, and advantages of peat in firing with brown coal and other low-grade fuels.

BOILER OPERATION

Load Indicators. Indicating Station Load in the Boiler Room, F. F. Leilich. Power, vol. 55, no. 15, Apr. 11, 1922, pp. 579–580, 4 figs. Automatic load indicator is described which has made it possible to hold steam pressures within prescribed limits under fluctuating loads and practically to prevent safety valves popping off.

Sugar Factories. Boiler House Operation in Sugar Factories (Kesselhauswirtschaft in Zuckerfabriken), H. Berner. Wärme, vol. 45, no. 3, Jan. 20, 1922, pp. 41–47, 11 figs. Deals with inherent difficulties in sugar factories; advantage of high boiler pressure; heat storage; saving of fuel through use of heating-gas preheater; high-pressure economizers, also for low-pressure boilers; forced-draft installations; practical tests on gas losses in anthracite furnaces; efficiency of the Eimert boiler-tube nests.

BOILERS

Cleaning. Cleaning Boilers by Means of Sand-Blast Apparatus (Reinigung von Dampfkesseln durch Sandstrahlgebläse), W. Kaempfer. Technische Blätter, vol. 12, no. 15, Apr. 14, 1922, pp. 153–154, 6 figs. Describes various experiences, especially with cleaning locomotive boilers; process requires about 200 kg. of sand per hr.

Furnace. See FURNACES, BOILER.

Locomotive. See LOCOMOTIVE BOILERS.

Marine. See MARINE BOILERS.

Settings. Progress in Boiler Setting (Fortschritte auf dem Gebiete der Dampfkesseleinmauerung), W. Ritter. Feuerungstechnik, vol. 10, no. 12 Mar. 15, 1922, pp. 125–126. Describes innovations in boiler brickwork.

Upkeep of Idle. Upkeep of Idle Boilers (La conservation des chaudieres en chomage), V. Kammerer. Bul. des Associations Françaises de Propriétaires d'Appareils a Vapeur, no. 3, Jan. 1921, pp. 133–138. Precautionary measures to keep out rust, contact with air or water, etc.

BOILERS, WATER-TUBE

Marine. A New American Water-Tube Boiler for Capital Ships. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 150–153 and 154–155, 2 figs. Features of experimental boiler designed by Rear-Admiral Dyson, U. S. N. and tested by Phila. Navy Yard.

BRAKES

Freight-Train, French. The Question of Continuous Brakes in the French Freight Trains (Die Frage der durchlaufenden Bremse für Güterzüge in Frankreich), H. Pechot. Organ für die Fortschritte des Eisenbahnwesens, vol. 77, no. 2, Jan. 15, 1922, pp. 17–22. Discusses experiments with air and vacuum brakes on French railways; also the Clayton Hardy, Kunze-Knorr, Westinghouse, and other brakes. Pp. 22–25, criticism by A. Führ.

BRASS

Cold Strip Rolling. American Practice in Cold Rolling Brass Strip, C. E. Davies. Metal Industry (Lond.), vol. 20, no. 13, Mar. 31, 1922, pp. 293–297, 2 figs. Points out that main points of difference in American from English practice are (1) machining or overhauling cast ingot before rolling; (2) increased rolling speeds; and (3) improved methods and appliances for handling and cleaning metal.

BROACHES

Pull. The Design of Pull Broaches. Machy. (Lond.), vol. 20, no. 497, Apr. 6, 1922, pp. 13–15, 4 figs. Depth of cut; pitch of teeth; length; shape of teeth; methods of attaching broaches to machines.

BRONZES

Cast, Analysis of. Notes on the Analysis of Cast Bronze, G. E. F. Lundell and J. A. Scherrer. Jl. of Indus. & Eng. Chem., vol. 14, no. 5, May 1922, pp. 426–429. Desirable procedures and precautions often ignored. Based on work done at Bur. of Stand. and by coöperating analysts.

BUSES

Gasoline-Electric, England. Gasoline-Electric Bus with Unusual Features Operated in England. Bus Transportation, vol. 1, no. 5, May 1922, pp. 283–284, 2 figs. Description of type carrying gasoline engine, dynamo and electric motor.

C

CABLEWAYS

Aerial Passenger. Suspended Railways for Passenger Service in Comparison with Surface Mountain Railways (Drahtseilschwebebahnen zur Beförderung von Personen im Vergleich zu ebenerdigen Bergbahnen), H. Gatzweiler. Verkehrstechnik, vol. 39, no. 12, Mar. 24, 1922, pp. 142–145, 3 figs. Describes Bleichert system of suspended cableway and points out advantages of such systems.

CALORIMETERS

Continuous-Flow. A Continuous-Flow Calorimeter, and the Determination of the Heat of Neutralization of a Solution of Hydrochloric Acid by one of Sodium Hydroxide, Frederick G. Keyes, Louis J. Gillespie and Shinroku Mitsukuri. Am. Chem. Soc. Jl., vol. 44, no. 4, Apr. 1922, pp. 707–717, 3 figs. Describes experiments carried out and apparatus used.

CALORIMETRY

Bomb Corrosion. The Effect of Bomb Corrosion on the Accuracy of Calorimetric Determinations, H. L. Olin and R. E. Wilkin. Chem. & Met. Eng., vol. 26, no. 15, Apr. 12, 1922, pp. 694–696. Describes experiments made with nickel-lined bombs.

CAMS

Calculation Calculation of Cams (Calcul des cames), Octave Lepersonne. Technique Automobile et Aerienne, vol. 12, nos. 113 and 114, 1921, pp. 33–42 and 68–71, 15 figs. No. 113: Discusses theory, determination of geometric form, application of straight line and arc profiles. No. 114: Graphic calculation and numerical examples.

CARS

Design Problems. Springs, Draft Gears and Other Problems in Car Design, Louis E. Endsley. Ry. Rev., vol. 70, no. 17, Apr. 29, 1922, pp. 591–594, 3 figs. Shorter spring travel and longer draft-gear travel suggested as solution to most serious problem. Address before Virginia Section of A.S.M.E.

Restaurant and Sleeping. Restaurant and Sleeping Cars for the Siamese State Railways. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, pp. 554–556, 11 figs. partly on pp. 559–560. Designed to afford maximum comfort to travelers; workmanship of highest class.

CAST IRON

Early History. The Early History of Iron with Special Reference to Cast Iron, J. Newton Friend. Foundry Trade Jl., vol. 25, nos. 290, 291 and 292, Mar. 9, 16 and 23, 1922, pp. 182–183, 193–194 and 216–218, 9 figs. Discusses iron in Egypt and Palestine, Mesopotamia, Europe, Great Britain and Central Africa; direct reduction of iron ores; reduction of iron in Africa; discovery of cast iron; 18th century developments.

Mechanical Tests. Mechanical Tests of Cast Iron (Considérations générales sur les essais mécaniques des fontes), M. Portevin. Révue Universelle des Mines, vol. 12, no. 6, Mar. 15, 1922, pp. 507–511. Discusses the various tests available and shows that some, such as the impact test, are of no value. Recommends tensile strength and Brinell tests.

CEMENT

Canadian Specifications. New Cement Specifications, Canadian Engineering Standards Association. Can. Engr., vol. 42, no. 17, Apr. 25, 1922, pp. 428–429. Résumé of new report from Can. Standards Assn. based also on specifications of Eng. Inst. of Canada, Am. Soc. for Testing Matls., and Brit. Standards for Portland Cement.

Fused. Fused Cement (Le Ciment fondu). Vie Technique et Industrielle, vol. 3, no. 30, Mar. 1922, pp. 503–506, 4 figs. Discusses French process for making cement containing 10 per cent silica, 40 alumina, 10 iron oxide, 40 lime, raised to temperature of complete fusion, and its properties and characteristics.

Hardening. Experiments on the Effect of Low Temperatures on the Hardening of Cement (Versuche über die Einwirkung von niedrigen Temperaturen auf das Erhärten des Zements), H. Kreüger. Beton u. Eisen, vol. 21, no. 5, Mar. 18, 1922, pp. 74–78, 4 figs. Discusses tests with cement cubes to show effect of freezing temperature and draws number of conclusions.

CENTRAL STATIONS

Heating and Power. Investigating the Efficiency of a Central Heating and Power Station (Wirtschaftliche Untersuchungen an einem Fern-Wärmekraftwerk), M. A. Nüscheler. Gesundheits-Ingenieur, vol. 45, no. 13, Apr. 1, 1922, pp. 169–177, 5 figs. Author's experience in construction and operation of steam piping for central heating stations, either in connection with central power stations or without it.

Superpower. Superpower System for Japan, C. A. Powel. Elec. Rec., vol. 31, no. 5, May 1922, pp. 357–359, 1 fig. Program for furnishing electricity over large area between Tokio and Osaka.

Hoover Sees Super-Power Project as Possible Stabilizer of Coal Industry. Min. Congress Jl., vol. 8, no. 5, May 1922, pp. 729–730. Theory that project in Atlantic Coast region between Washington, D. C. and Portland, Me., might stabilize coal industry.

CHIMNEYS

Heat Losses in. The Relation Between CO_2 and Stack Losses. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 429–431, 3 figs. Discusses various factors governing chimney loss, and shows that the magnitude of chimney loss bears definite relation to percentage of CO_2 in flue gases.

CLUTCHES

Magnetic. Magnetic Clutches in the Cement Industry, W. H. Costello. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 5, May 1922, pp. 361–363, 2 figs. Clutch requirements and description of magnetic type which meets them.

Systems. Study of the Various Clutch Systems (Étude des divers systèmes d'embrayages), Henri Petit. Technique Automobile et Aerienne, vol. 13, no. 116, 1922, pp. 4–17, 28 figs. Describes English and American gear systems for automobiles, including cone clutches and disk clutches, and gives tabulated statement of their characteristics.

COAL

Analysis. Coal Analyses May Be Misleading Because of Crude and Insufficient Sampling, O. P. Hood. Coal Age, vol. 21, no. 12, Mar. 23, 1922, pp. 484–486. Advises averaging of numerous samples taken over long period to get representative value. Based on address before Nat. Assn. Purchasing Agents.

Coking Propensities. The Coking Propensities of Coals, W. A. Bone, A. R. Pearson, E. Sinkinson, W. E. Stockings. Gas World, vol. 76, no. 1967, Apr. 1, 1922, pp. 16–20, 1 fig. Results of experimental investigations into resinic constituents of bituminous coals and their supposed determining influence upon coking propensities of coals. (Abstract.) Paper read before Royal Soc.

Combustion. Combustion of Coal, R. B. MacMullin. Combustion, vol. 6, no. 3, Mar. 1922, pp. 118–123, 5 figs. Composition and classification of coal; oxidation of carbon.

Recovery from Ashes of Coke and. Recovery of Coke and Coal From Ashes (Rückgewinnung von Koks und Kohlen aus Asche), Ullrich. Montanistische Rundschau, vol. 14, nos. 3 and 7, Feb. 1 and Apr. 1, 1922, pp. 56–58 and 153–156, 7 figs. Describes electromagnetic ash separators and shaking tables, and gives results of some experiments with ashes from anthracite firing at experiment station of Krupp-Gruson works.

Sampling. Sampling Fuel (Prélèvement et préparation d'un échantillon moyen de combustibles). Bul. des Associations Françaises de Propriétaires d'Appareils a Vapeur, no. 6, Oct. 1921, pp. 330–331, 1 fig. Procedure adopted by French associations for drawing and preparing average sample of coal.

COAL GAS

Economical Use. Economical Use of Illuminating Gas (L'emploi economique du gaz d'eclairage), R. Villers. Nature, no. 2500, Mar. 4, 1922, pp. 134–138, 7 figs. Various uses of the gas; types of burners; proper mixing with air; compressing.

COAL HANDLING

Bunkering Cranes. Recent Developments in Bunkering Cranes, Cargo, Coal Loading Equipment and Shipbuilding Cranes, Justin Griess. World Ports, vol. 10, no. 6, Apr. 1922, pp. 47–55. Describes methods for bunkering coal at various harbors.

Equipment. Coal and Ash-Handling Equipment, Harry R. Westcott. Steam, vol. 29, no. 4, Apr. 1922, pp. 93–100. Description of various units from yard storage through traveling bridges, feeders, chain elevators and conveyors to ash hoppers.

COAL STORAGE

Methods. Coal Storage (La conservation des charbons), E. Schmidt. Bul. des Associations Françaises de Propriétaires d'Appareils à Vapeur, no. 4, Apr. 1921, pp. 165–181. Discusses change in coal exposed to air, spontaneous combustion, storage under water, coal piles, etc.

COKE BREEZE

Steam Generation. The Utilization of Coke Breeze for the Generation of Steam, W. Francis Goodrich. Gas Engr., vol. 38, no. 550, Feb. 15, 1922, pp. 44–46. Features of this fuel which make it of real value.

COLD STORAGE

Indirect Air Cooling. Indirect Air Cooling for Cold Storage—A Problem in Design, H. E. Corl. Refrigeration, vol. 29, no. 8, Mar. 1922, pp. 26–28, 1 fig. Considerations necessary in design; refrigeration; bunker coil surfaces; selection of fan and motor; thermostatic control of temperature.

COMBUSTION

Coal. Combustion of Coal, R. B. MacMullin. Combustion, vol. 6, no. 5, May 1922, pp. 224–228, 4 figs. Relation between temperature, excess air, and rate of combustion.

COMPRESSED AIR

Mines. Determining the Drop in Pressure in Compressed Air Piping in Mines (Ermittlung des Druckabfalls in Pressluftleitungen untertage), W. Reinhard. Glückauf, vol. 58, no. 15, Apr. 15, 1922, pp. 433–436, 1 fig. Discusses drop due to pipe resistance, and gives chart from which average loss of head can be calculated.

CONDENSERS, STEAM

Steam. Season Cracking in Condenser Tubes. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 461–462, 6 fig. Cracking of tubes. Study of costs and suggestions toward elimination.

CONVEYORS

Belt. Biggest Belt-Conveyor System in the World, D. R. Egbert. Belting, vol. 20, no. 4, Apr. 1922, pp. 17–25, 5 figs. Parcel-post station in Chicago to be completed June 1922, will have 8 miles canvas-stitched belting. Description of installation, largest in world.

Monorail. Monorail Conveyors on Clay Plants. Brick and Clay Rec., vol. 60, no. 8, Apr. 18, 1922, pp. 613–615, 9 figs. This type desirable for clay plants. Description of installations at R. Thomas & Sons, East Liverpool, Ohio, and Brooklyn (Ind.) Brick Co.

Steel-Belt. Flexible Steel Belt Conveyors, Harry Carlson. Gas Age-Rec., vol. 49, no. 13, Apr. 1, 1922, pp. 383–385, 6 figs. Describes steel belt made by Sandviken Steel Works, Sweden, and gives particulars as to strength, corrosion, loading width, etc.

Steel-Band Conveyors. Eng. Progress, vol. 3, no. 5, May 1922, pp. 109–110, 13 figs. Application and advantages of steel-band conveyors of Sandviken type.

Telphers vs. Telphers vs. Conveyors for Gas Works Purposes, Herbert Blyth. Gas. Engr., vol. 38, no. 549, Jan. 16, 1922, pp. 6–7, 2 figs. Features of gas manufacturing plant and comparative advantages of overhead telphers and conveyor systems.

COOLING TOWERS

Recooling of Water in. Recooling Plants (Ueber Rückkühlanlagen), Fritz Hoyer. Wärme, vol. 45, no. 6, Feb. 10, 1922, pp. 77–80, 7 figs. Desiderata for obtaining good results from cooling installations. Details and advantages of modern types.

CORROSION

Colloids, Influence of Protective. The Influence of Protective Colloids on the Corrosion of Metals and on the Velocity of Chemical and Physical Change, John A. N. Friend and Reece H. Vallance. Chem. Soc. Jl., vol. 121–122, no. 713, Mar. 1922, pp. 466–474, 2 figs. Concludes that after a general law protective colloids tend to retard velocity of such reactions as involve change of state from solid to liquid, or vice versa, in one or more of the components.

Ferrous Metals. Corrosion of Ferrous Metals, Robert Abbott Hadfield. Metal Industry (Lond.), vol. 20, no. 16, Apr. 21, 1922, pp. 381–382. Preparation of various ferrous metals used in corrosion research of Inst. Civil Engrs. together with their physical and mechanical properties and some general considerations on subject of corrosion. (Abstract.) Paper read before Inst. Civil Engrs.

Rust Prevention. The Prevention of Rust. Motor Transport, vol. 34, no. 896, May 1, 1922, p. 529, 1 fig. Notes on application of thermozine process for protecting certain parts of motor vehicles against corrosion.

Oxidization Prevention. Calorizing and Calite, G. H. Howe and G. R. Brophy. Gen. Elec. Rev., vol. 25, no. 5, May 1922, pp. 267–272, 5 figs. Description of process developed in Schenectady Research Laboratory to prevent corrosion.

COST ACCOUNTING

Depreciation and Retirement of Property. Depreciation and Retirement of Property, William H. Bell. Jl. of Accountancy, vol. 33, no. 4, Apr. 1922, pp. 253–258. Shows that where average rate of depreciation is used, if a unit of property is retired in advance of average estimated life of all units in its class, entire cost of unit retired should be charged to reserve for depreciation.

Engineering Methods Applied to. Engineering Methods Applied to Cost Finding, Robert S. Denham. Indus. Management, vol. 63, nos. 2, 3, 4 and 5, Feb., Mar., Apr. and May, 1922, pp. 67–73, 161–166, 218–220, and 310–312, 4 figs. Feb.: Effect upon profit margin of traditional and misleading cost methods. Mar.: General principles underlying application of expense items. Apr.: Six fundamental principles of cost engineering. May: Definite procedure for surveying the requirements of production.

Factory. Factory Accounts, Costs, and Statistics, R. Dunkerley. Foundry Trade Jl., vol. 25, nos. 293 and 294, Mar. 30 and Apr. 6, 1922, pp. 233–235 and 248–249. Comparative factory expenses; underlying principles and essential details; foundry tackle; monthly statements; individual costs; overhead charges; wasters; etc.

New Plan. Cost Accounting, Guy Foote Wetzel. Armour Engr., vol. 13, no. 3, Mar. 1922, pp. 163–174. Discusses cost accounting plan with some new features, by A. W. Torbet, installed in large manufacturing plant, and compares with usual methods.

Scientific, Necessity for. Costing in Industry. Eng. & Indus. Management, vol. 7, no. 12, Apr. 20, 1922, pp. 357–360. First part of special report of Costing Conference held in Lond., covering cost accountant's position, works expenditure, periodical comparisons, and productive labor.

COTTON INDUSTRY

Electrical Equipment. The Electrical Equipment of the D. R. Cotton Mills. Electrician, vol. 88, no. 2292, Apr. 21, 1922, pp. 473–474, 4 figs. Some details of mills which contain both spinning and weaving sections.

CRANES

Classification. Classification of Hoisting Machines Particularly Cranes (Einteilung der Hebe- und Transportmaschinen, insbesondere der Krane), R. Dub. Fördertechnik u. Frachtverkehr, vol. 15, nos. 1 and 2, Jan. 6 and 20, 1922, pp. 1–4 and 22–26, 59 figs. Classification of the various types of cranes into groups according to their kinematic characteristics, assuming that load is always concentrated at center of gravity.

Floating. A 60-ton Floating Crane, W. Fox. Mech. World, vol. 71, nos. 1837 and 1838, Mar. 17 and 24, 1922, pp. 207–209 and 224–226, 10 figs. Describes in detail revolving jib type floating crane, built by Werf Gusto (Firma A. F. Smulders), Schiedan, Holland.

Inspection. Things that the Crane Inspector Looks for and Some of the Hows and Whys, A. L. Gear. Elec. Rev. & Indus. Engr., vol. 80, no. , Mar. 1922, pp. 111–118, 152, 1: figs. Inspection report forms and things looked for in making inspection

Wrecking. Ten-Ton Locomotive Steam Breakdown Crane. Engineer, vol. 133, no. 3457, Mar. 31, 1922, p. 357, 3 figs. partly on p. 360. Built by Bedford Engineering Co., Bedford, England, for Great Western of Brazil Ry., and designed to lift loads up to 10 tons at radius of 20 ft.

CRANKSHAFTS

Steel for. Steel for Crankshafts: Its Heat Treatment, H. C. Loudenbeck. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 181–183. Grades of steel that are being used for this purpose, and their heat treatment and physical properties to secure best results.

CUPOLAS

Charging Elevator, Combined with. An Improved Foundry Melting Plant. Engineer, vol. 133, no. 3457, Mar. 31, 1922, pp. 365–366, 3 figs. Describes plant designed by J. E. Hurst for regular production of high-grade cast iron for use in manufacture of castings by centrifugal-casting process. Consists of a cupola, an elevator charging arrangement and an oil-fired receiver.

Design and Operation. Iron and Foundry Cupola Management, J. J. McClelland. Foundry Trade Jl., vol. 25, no. 292, Mar. 23, 1922, pp. 209–213, 5 figs. Author's experience in cupola practice; describes layout of plant, construction of cupola, linings, charging, fans or blowers, etc. Paper read before Instn. British Foundrymen.

Iron Melting. Cupola Practice, J. Wood. Foundry Trade Jl., vol. 25, nos. 296 and 297, Apr. 20 and 27, 1922, pp. 288–290 and 304–306, 3 figs. Some difficulties that have to be overcome in melting iron by cupola process which, for quickness and cheapness, is not excelled by any other furnace. Details of lining and tuyeres. Paper read before Instn. British Foundrymen.

D

DIESEL ENGINES

Flexibility. Diesel Engine Flexibility, W. S. Burn. Steamship, vol. 33, no. 394, Apr. 1922, pp. 320–331, 9 figs. Investigation with view to its application to direct-driven Diesel locomotive. It is shown that principles governing flexibility are practically identical with those governing economy. Read before Graduate Section of North-East Coast Instn. Engrs. & Shipbuilders.

Generator Drive. Oil-Engine-Driven Ship Generators in the German Navy (Der ölmotorische Antrieb von Borddynamos in der deutschen Kriegsmarine), W. Laudahn. Schiffbau, vol. 23, nos. 13, 14, 15, 16, 19–20, 21, 23 and 25–26, Dec. 28, 1921, and Jan. 4, 11, 18, Feb. 8–15, 22, Mar. 15 and 22–29, 1922, pp. 363–369, 397–403, 429–435, 467–470, 565–573, 605–614, 745–752 and 777–780, 93 figs. Dec. 28: The 300-kw. Diesel engine built by Körting Bros., Inc., for liner, König. Jan. 4: Engine of Fried. Krupp Corp. Germania Shipyard for liner Kronprinz. Jan. 11 and 18: Engine of Benz & Co., Mannheim, for liner Bayern. Feb. 8: Engine of Vulcan Works, Inc., Hamburg for liner Württemberg. Feb. 22: Engine of Augsburg-Nürnberg Corp. for large cruiser. Lützow. Mar. 15 and 22: Engine of Görlitzer Machine Constr. & Iron Foundry Corp. for large cruiser Hindenburg.

Heavy and Low-Grade Oil. Using Heavy and Low Grade Oil in Motors of the Diesel Type (Mineria y Petróleo), Benigno Benigni. Ingenieria, vol. 26, no. 3, Mar. 1922, pp. 133–135, 1 fig. Some experiments with Ansaldo San Giorgio engines running on cotton-seed and palm oils.

Lighter. Use Diesel Unit for Lighter. Mar. Rev., vol. 52, no. 5, May 1922, pp. 215–217, 3 figs. Installation of unit on derrick lighter Worthington, owned by Worthington. Pump & Machy. Corp. develops 300 b.hp. at 275 r.p.m.

Locomotive. Industrial and Scientific Progress. Beama, vol. 10, no. 4, Apr. 1922, pp. 295–298. Description of air auxiliary cylinders with Diesel engine which give sufficient flexibility for use on locomotives; designed by W. S. Burn who presented paper on subject before N. E. Coast Instn. Engrs. & Shipbuilders.

Marine. A 1000-Hp. Marine Diesel Engine of the German Works, Inc. (Ein 1000 PS-Schiffs-Dieselmotor der Deutschen Werke A.-G.), P. Stephan. Motor u. Auto, vol. 19, no. 5, Mar. 15, 1922, pp. 65–68, 2 figs. Also Schiffbau, vol. 23, no. 27, Apr. 5, 1922, pp. 815–824. Describes engine recently completed in Kiel shipyard which is one of two engines to be installed in a tanker with 8000-ton displacement built for the Italian Government. It is 6.6 m. high and has six 4-stroke single-acting cylinders.

Injection and Combustion of Fuel-Oil—IX, C. J. Hawkes. Motorship, vol. 7, no. 5, May 1922, pp. 366–367, 4 figs. Experiments with solid-injection and air-blast in marine Diesel engines. (Concluded.)

The Beardmore-Tosi Diesel Engine. Steamship, vol. 33, no. 394, Apr. 1922, pp. 332–338, 9 figs. Presents table showing relative cost of fuel, oil, and personnel for two types of vessels, one steam-driven and the other Diesel-driven. Details of Beardmore-Tosi marine engines.

DRAFT

Equalized. The Significance of Equalized Draft (Wesen und Bedeutung des ausgeglichenen Zuges), Hch. Doevenspeck. Wärme, vol. 45, no. 9, Mar. 3, 1922, pp. 111–113, 2 figs. Discusses questions relating to natural and forced draft and advantages of equalized draft.

DRILLING MACHINES

Pneumatic. Pneumatic Drilling Machines and Hammers in Mining and Related Industries (Druckluft-Bohrmaschinen und -Hammer im Bergbau und in den verwandten Betrieben), R. Goetze. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 11 and 12, Mar. 18 and 25, 1922, pp. 245–251 and 278–280, 42 figs. History of development and description of most important modern types of drilling machines, hammers and picks. Prospects of future development.

DROP FORGINGS

Difficulties. How Drop Forgings are Made Perfect, J. H. G. Williams. Raw Material, vol. 5, no. 4, May 1922, pp. 140–143, 14 figs. Summarizes chief difficulties in production of faultless drop forgings. Paper presented at N. Y. Sectional Meeting of Am. Soc. for Steel Treating.

Modern Practice. Modern Drop-Forging Practice—II. Machy. (Lond.), vol. 19, no. 487, Jan. 26, 1922, pp. 508–511, 7 figs. Deals with trimming of forgings and correct forging heats, and gives typical examples of drop-forging work.

DRYING

Wood. Note on Drying (Note sur le séchage), P. Villain. Révue de l'Industrie Minérale, no. 31, Apr. 1, 1922, pp. 155–170, 10 figs. General principles of drying methods as applied in mining and metallurgy, especially of woods.

DURALUMIN

Properties and Commercial Possibilities. Duralumin Properties and Commercial Possibilities. Brass World, vol. 18, no. 4, Apr. 1922, pp. 129–130. Characteristics of this material, one-third the weight of cold-rolled steel though with same approximate strength.

Welding. Welding Duralumin—Some Experimental Work and Its Results, Horace C. Knerr. Automotive Industries, vol. 46, no. 18, May 4, 1922, pp. 964–968, 10 figs. Account of experimental work done at Naval Aircraft Factory and results attained from this work and from weld made by private firm. Details of tensile and corrosion tests made on different types of welds.

E

EDUCATION, INDUSTRIAL

Electricians. Practical Training and Professional Courses in the Electric Industries (Role de l'École pratique et des Cours professionnels dans les industries électriques), E. Labbé. Révue Générale de l'Électricité, vol. 11, nos. 10 and 11, Mar. 11 and 18, 1922, pp. 367–372 and 405–414, 10 figs. Mar. 11: Kind of training best for practical industrial schools to train skilled electricians. Mar. 18: Machinery and apparatus necessary for instruction, and their practical operation.

ELECTRIC DRIVE

Changing from Steam. Changing From Steam to Electric Drive. Wood-Worker, vol. 41, no. 2, Apr. 1922, pp. 38–39, 1 fig. In case cited herewith a large plant changes from steam to electric drive, but instead of scrapping old power-transmission equipment, latter is retained in sections which now constitute motor-driven group drives.

ELECTRIC FURNACES

Aluminum Melting. Melts Aluminum in Electric Furnace, H. E. Diller. Foundry, vol. 50, no. 9, May 1, 1922, pp. 345–357, 10 figs. Daily and monthly operating reports indicate power required and other data. Core sand all reused; sand driers prove economical; patterns fitted in wooden matches.

Annealing. Regenerative Car Type Electric Furnace, A. D. Dauch. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 200–201, 4 figs. Describes annealing furnace of Fowler and Union Horse Nail Co., Buffalo, N. Y.

Electromagnetic Motion. Electromagnetic Motions in Electric Furnaces. Brass World, vol. 18, no. 4, Apr. 1922, pp. 117–119. Method of applying in practice forces suggested in paper by Carl Hering, read at Apr. 1921 meeting of Am. Electrochem. Society.

Non-Ferrous. Non-Ferrous Electric Furnaces, F. Kilburn and H. C. Dews. Foundry Trade Jl., vol. 25, no. 296, Apr. 20, 1922, pp. 281–282. Furnaces for low-melting-point alloys, below 800 deg. cent.; for medium-melting-point alloys, between 800 to 1,300 deg. cent.; and for high melting point alloys, above 1300 deg. cent. (Abstract.) Paper read before West Yorkshire Metallurgical Soc.

Operation. Changes in the Working of an Electric Furnace (Remarques au sujet des changements d'allure dans les hauts-fourneaux électriques), J. Seigle. Révue de Métallurgie, vol. 19, no. 2, Feb. 1922, pp. 86–89. Difference in blast and electric furnaces in reduction of oxides by carbon and formation of CO and CO_2.

Resistance-Type, Graphites for. Electric-Resistance Furnace for High Temperatures (Elektrisk motståndsugn for höga temperaturer), Bo Kalling. Teknisk Tidskrift (Utgiven av Svenska Teknologföreningen), vol. 52, no. 9, Mar. 4, 1922, pp. 146–148, 3 figs. Resistance of Acheson and Scandinavian graphites at various temperatures.

ELECTRIC LOCOMOTIVES

Chile Freight Service. Electric Freight Locomotives for Chile. Ry. Age, vol. 72, no. 17, Apr. 29, 1922, pp. 1005–1006, 2 figs. Work on fifteen for Chilean State Rys. nearing completion. Operated at 3000 volts d.c.; maximum speed, 40 m.p.h.; estimated weight, 226,000 lb.

Electric Locomotives for Chile Freight Service, F. E. Wynne. Elec. Ry. Jl., vol. 59, no. 16, Apr. 22, 1922, pp. 667–672, 15 figs. Details of road and switching locomotives soon to be delivered to Chilean State Rys. are given. Designs provide for incorporation into present railway system while not preventing further standardization.

Single-Phase, France. Single-Phase Electric Traction on the System of the Camargue R. R. Co. (Application de la traction électrique par courant monophasé sur le réseau de la Compagnie des Chemins de Fer de la Camargue), J. Reyval. Révue Générale de l'Électricité, vol. 11, no. 10, Mar. 11, 1922, pp. 351–359, 12 figs. Discusses recently electrified lines Nîmes-Arles Trinquetaille and Nîmes-Saint Gilles, and advantages derived; 6600 volts, 25 cycle.

ELECTRIC PLANTS

Hell Gate Station. Hell Gate—A Station of Many Features. Elec. World, vol. 79, no. 17, Apr. 29, 1922, pp. 821–827, 11 figs. Unusual features are turbine room next to river, phase isolation of all electrical equipment, alternating-current-driven auxiliaries.

Humanized. A Humanized Plant, R. C. Denny. Combustion, vol. 6, no. 5, May 1922, pp. 218–220, 4 figs. Cannon St. plant of New Bedford Gas & Edison Light Co. designed for best performance of man power and mechanical equipment and operating at 1.7 lb. of 14,000 B.t.u. New River Coal to the kw.

Winnipeg River. The Next Big Western Power Scheme. Contract Rec., vol. 63, no. 17, Apr. 26, 1922, pp. 372–375, 6 figs. Manitoban Power Co. actively developing Great Falls, Winnipeg River. Contracts let for two complete 28,000 hp. units. Complete capital cost will be less than $80 per hp.

ELECTRIC POWER

Scientific Application to Factory Problems. Applying Electricity Scientifically to Factory Problems, Louis F. Leurey. Jl. Electricity & West. Industry, vol. 48, no. 9, May 1, 1922, pp. 343–345, 3 figs. Example of what can be done in adapting electricity to special needs of a factory as illustrated by modern equipment and carefully planned layout of California and Hawaiian sugar plant.

ELECTRIC RAILWAYS

Track and Wiring on Bridge. Track and Wiring on Large Bridge. Elec. Ry. Jl., vol. 59, no. 14, Apr. 8, 1922, pp. 587–591, 11 figs. Describes overhead wire and track construction on new bridge across Housatonic River, which has just been completed by Connecticut Co.

EMPLOYEES' REPRESENTATION

Works Councils. Industrial Representation and the Fair Deal. George H. Shepard. Indus. Management, vol. 63, nos. 2, 3, Feb., Mar. 1922, pp. 81–85, 185–188. Deals with fundamentals of contact with employees to stimulate production. Coöperation by managers and employees through works councils.

ENGINEHOUSES

Chesapeake & Ohio. New Locomotive Facilities at Clifton Forge, Va. Ry. Age, vol. 72, no. 16, Apr. 22, 1922, pp. 955–958, 13 figs. New 10-stall installation at Clifton Forge, Va., which includes power house capable of 1100 b.hp., storehouse and oil house.

EXECUTIVES

Functions and Methods of Chief. A Technique for the Chief Executive, John H. Williams. Taylor Soc. Bul., vol. 7, no. 2, Apr. 1922, pp. 47–68. Notes on responsibilities and duties of chief executive and a method through which he might function effectively.

Problem of Chief. The Problem of the Chief Executive, Henry P. Kendall. Taylor Soc. Bul., vol. 7, no. 2, Apr. 1922, pp. 39–46. From point of view of medium-sized enterprise.

EXPORT TRADE

Packing for. Packing for Export, P. J. Burns. World Ports, vol. 10, no. 6, Apr. 1922, pp. 69–75. Discusses prevention of pilfering and damage, marking and packing of shipments, and coöperation between exporters and transportation companies.

F

FANS

Mine. Selection of Fans for Pipe Ventilation, Walter S. Weeks. Eng. & Min. Jl.-Press, vol. 113, no. 119, May 13, 1922, pp. 816–818, 3 figs. Theory of operation and calculations to be made in choosing equipment for assuring proper supply of pure air and for fire fighting; computation of characteristic curves at different speeds; discussion limited to small fans.

FEEDWATER HEATERS

Locomotive. Locomotive Feed Water Heaters, H. B. Oatley. Southern & Southwestern Ry. Club, vol. 16, no. 7, Jan. 19, 1922, pp. 14–37 and (discussion) pp. 37–45, 19 figs. General discussion of development and prospects, with suggestions as to operation.

FIRE HOSE

Coupling Standardization. Progress in Hose Coupling Standardization, F. M. Griswold. Nat. Fire Protection Assn., vol. 15, no. 3, Jan. 1922, pp. 246–249. Discusses importance of standardization in fire-fighting equipment.

FIRE PREVENTION

Automatic Devices. Automatic Devices for Preventing Fires in Buildings (Dispositifs automatiques de protection des édifices contre l'incendie), Jacques Michaut. Génie Civil, vol. 80, no. 13, Apr. 1, 1922, pp. 295–299, 8 figs. Deals with sprinkler systems such as Grinnell type, automatic fire alarms, etc.

Fire-Alarm Code. Many Changes Planned for Fire Alarm Code, C. E. Beach. Fire & Water Eng., vol. 71, no. 18, May 3, 1922, pp. 727–728, 730 and 742. Comment on proposed changes in fire-alarm code by former engineer of large fire alarm establishment.

Water Supply, Relation of. Fire Service as it Relates to Water Supply, Dow R. Gwinn. Mun. & County Eng., vol. 62, no. 4, Apr. 1922, pp. 148–154. Several features of water problem in this field.

FLIGHT

Soaring. Flying Without Engine (Étude théorique du vol sans moteur), Alayrac. Aeronautique, vol. 4, no. 34, Mar. 1922, pp. 75–78. Discusses theory of gliding and wind conditions, and reduces it to mathematical formulas.

The Velocity of Descent of Gliding Airplanes (Zur Sinkgeschwindigkeit von Segelflugzeugen) Erik Thomas. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 6, Mar. 31, 1922, pp. 78, 4 figs. Gives mathematical determination of minimum velocity of descent for gliding plane whose area is constant, and for gliding plane whose spread of wings is constant.

FLOW OF WATER

Weirs. Experiments With Flow Over Weirs With End Contractions (Expériences sur des déversoirs a nappe libre avec contraction latérale), V.-M. Hegly. Annales des Ponts et Chaussées, vol. 6, Nov.-Dec. 1921, pp. 290–389, 43 figs. Gives results of measurements of flow for triangular, semicircular, multiple, and other discharges in connection with Marne-Saône canal.

FLYING BOATS

Amphibian. The Supermarine Single-Seater Fighting Scout "Sea King" Mark II. Flight, vol. 14, no. 16, Apr. 20, 1922, pp. 226–229 and 236, 13 figs. Description of interesting amphibian flying boat with 300-hp. Hispano-Suiza engine.

FOUNDRIES

Castings, Cost of. System Keeps Tab on Foundry Costs, H. C. Keller. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 308–310 and 315, 9 figs. Outlines simplified method for finding costs of castings; suitable for small shops.

Handling Products. Heavy Tonnage from a Small Floor. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 301–307, 10 figs. Discusses coördination of supply of materials and sequence of operation as essential to molding and pouring of castings.

Heating Units, Manufacture of. Heater Sections Made in Quantity. Foundry, vol. 60, no. 7, Apr. 1, 1922, pp. 267–274, 12 figs. System of providing large and continuous vents in cores automatically removes most dangerous factor in producing castings of this character.

FUELS

Automobile. See AUTOMOBILE FUELS.

Hogged. Hogged Fuel, Emery A. Morrison. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 407–410, 4 figs. Its heat-producing value; design and adaptability of furnace; means and method of handling fuel to furnace grates. From paper read before Western Section of Am.Soc.Mech.Engrs.

Low-Grade. Contributions to the Improvement of German Fuel Economy (Beiträge zur Verbesserung der deutschen Brennstoffwirtschaft), Otto Brandt. Wärme (formerly Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, nos. 4, 5 and 6, Jan. 27, Feb. 3 and 10, 1922, pp. 53–55, 68–71 and 81–83. Discusses use of peat, lignite and other low-grade fuels and design of furnaces for their use; distribution and efficient exploitation of high-grade fuels; utilization of German crude oil; water-power utilization, etc. Future prospects.

PreCarbonization. Precarbonization of Fuels (La carbonisation préalable des combustibles). Outillage, vol. 253, no. 13, Apr. 1, 1922, pp. 377–380, 4 figs. Low-temperature carbonization; tar distillation; low-grade fuels, etc.

[See also COAL; GAS; LIGNITE; OIL FUEL; PULVERIZED COAL.]

FURNACES, BOILER

Oil. New Oil Furnaces (Neue Oelfeuerungen), H. Pradel. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 10–12, 9 figs. Details of various types constructed by Körting Bros., Inc., near Hannover, Germany, including steam-jet centrifugal oil furnaces, low-pressure burners, etc.

FURNACES, FORGING

Heating Arrangements. The Need for Better Heating in Forging and Forming Practice. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 202–204, 2 figs. Typical arrangements of chambers and working openings in forging and heating furnaces to meet nature of process and material to be heated.

FURNACES, METALLURGICAL

Design. Possibilities of Improvements in the Design and Operation of Metallurgical Furnaces (Entwicklungsmöglichkeiten bei hüttentechnischen Oefen), Georg Bulle and H. Rosin. Stahl u. Eisen, vol. 42, no. 14, Apr. 6, 1922, pp. 529–532, 3 figs. Author demonstrates importance of taking radiation losses into consideration and points out that great saving in fuel can be effected through proper shape and size of furnace and adequate insulation. Practical examples.

Gas Firing. Modern Gas Firing (Neuzeitliche Gasfeuerungen), M. Schimpf. Glückauf, vol. 58, no. 15, Apr. 15, 1922, pp. 429–433, 5 figs. Discusses question of using surplus gas in mining districts, and describes experiments with Eickworth and Rodberg burners for burning furnace and excess gas.

Oil-Fired. Oil Firing of Open-hearth Furnaces in Steel Foundries (Le Chauffage à l'Huile des Fours Martin), P. Jolly. Fonderie Moderne, no. 3, Mar. 1922, pp. 78–79. Discusses advantages of oil, such as absence of sulphur, regulation of temperature, intermittent operation, etc.

Temperature Calculation. Calculation of Working Temperatures in Metallurgical Furnaces (Errechnung der Arbeitstemperaturen in metallurgischen Oefen), Hugo Bansen. Stahl u. Eisen, vol. 42, nos. 7, 8, 10 and 11, Feb. 16, 23, Mar. 9 and 16, 1922, pp. 245–253, 291–297, 370–375 and 423–426, 17 figs. Notes on drop in temperature as calculated and actually reached; pyrometric evaluation of fuels; dynamic conditions for flame formation; required workpiece temperatures; temperature pressure between workpiece and flame; heat transmission. Determination of most suitable fuel.

FURNACES, OPEN-HEARTH

Regenerative. Control of Heat Economy in Regenerative Furnaces (Ueberwachung der Wärmewirtschaft bei Regenerativefeuerungen), H. Berger. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 12–14. Includes heat balance of regenerative furnace and auxiliary

generator. Notes are given both on sources and prevention of losses.

G

GAS

B.t.u. Calculation. New Graphic B.t.u. Calculator, Minor C. K. Jones. Gas Age-Rec., vol. 49, no. 13, Apr. 1, 1922, pp. 392–394, 1 fig. Discusses use of chart for calculation of heating value in B.t.u. per cubic foot of a gas, by which lengthy and laborious calculations are avoided.

Fuel, Future Use. Gas—the Fuel of the Future, Thomson King. Am. Gas Jl., vol. 116, no. 14, Apr. 8, 1922, pp. 321–322 and 332–335. Deals with near future which can be plainly discerned, and more distant future which must be dealt with in more general terms.

Proper Utilization. Proper Utilization of Gas Important, Andrew M. Rowley. Oil & Gas Jl., vol. 20, no. 48, Apr. 27, 1922, p. 12, 1 fig. Domestic consumers waste 150 billion ft. annually, hastening depletion of supply and bringing closer day of costly substitutes.

Relative Usefulness of. Relative Usefulness of Gases, Floyd W. Parsons. Gas Age-Rec., vol. 49, no. 16, Apr. 22, 1922, pp. 483–484, 506. Results of investigation of different gases by U. S. Bur. of Standards. Proper burning conditions of air to gas and most economic heating value standards for gas.

GAS PRODUCERS

Glass Works. Gas-Producer Operation in Glass Works (Der Betrieb der Gaserzeuger in den Glashütten), Hubert Hermanns. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 14–17, 5 figs. Presents heat balance of a glass furnace and discusses losses in Siemens producers.

Outside. Outside Producers at Racine, H. R. Broker. Am. Gas Jl., vol. 116, no. 14, Apr. 8, 1922, pp. 325–328, 4 figs. Notes on installation of producer plant consisting of two high-pressure producers which can gasify at least one-half braize and one-half small or nut coke, and each of which is rated to gasify 25 tons of fuel per day. Saving effected in labor and fuel.

Reinforced-Concrete. Reinforced-Concrete Gas Producer. Engineer, vol. 133, no. 3457, Mar. 31, 1922, p. 364, 2 figs. Experimental producer built in Italy in accordance with patents of O. R. Verity. It is claimed that reinforced-concrete construction allows of economy in first cost of over 50 per cent, as compared with metal construction, and there is also economy in maintenance.

Transforming Solid Fuel into Gas. Gas Generator, Fusing Ash Type (Le gazogène à fusion dess cendres), A. Fichet. Mémoires et Comptes Rendus des Travaux de le Société des Ingenieurs Civils de France, vol. 74, no. 10–12, Oct.-Dec. 1921, pp. 595–638, 8 figs. Development of Ebelmen gas producer for transforming solid fuel into gas and using this in metallurgical furnaces.

Types. Gas Producers (Les Gazogènes), Louis Garand. Chaleur et Industrie, vol. 3, no. 24, Apr. 1922, pp. 1187–1192, 3 figs. Reviews development and describes most recent types made in France.

GAS TURBINES

Thyssen-Holzwarth Oil and. Thyssen-Holzwarth Oil and Gas Turbines, W. Schüle. Motorship, vol. 7, no. 5, May 1922, pp. 351–355, 9 figs. Describes unique internal-combustion engine invented by Hans Holzwarth, and gives results of tests. (Extract.) Translated from German.

GASES

Combustion of Mixtures. The Combustion of Complex Gaseous Mixtures. William Payman and Richard Vernon Wheeler. Chem. Soc. Jl., vol. 121–122, no. 713, Mar. 1922, pp. 363–379. Concludes that during propagation of flame in mixture of several inflammable gases with air at given speed, gas which will monopolize most oxygen is that which when burning alone with same speed of flame is associated with most air.

GASOLINE

Substitutes. Gasoline Substitutes and Synthetic Products, Ernest Owen. Oil Trade Jl., vol. 13, no. 4, Apr. 1922, pp. 13–14 and 92. Development of cracking processes; methods designed to conserve fuel; using catalysts; oil-shale projects, and principal shale sources; alcohol a promising source.

GEAR CUTTING

Commercial Practice. Commercial Gear-cutting Practice. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 33–36, 20 figs. Spur gear-cutting machines of rotary-cutter type.

Commercial Gear-Cutting Practice. Machy. (Lond.), vol. 20, no. 500, Apr. 27, 1922, pp. 109–112, 6 figs. Describes automatic spur gear cutter by John Holroyd & Co., Ltd.

Multiple Shapers. Stevenson Multiple Gear Shaper. Machy. (Lond.), vol. 19, no. 496, Mar. 30, 1922, pp. 791–793, 5 figs. Describe new 6-A downstroke model.

GEAR DRIVE

Nodal Arrangements of. Nodal Arrangements of Geared Drives, J. H. Smith. Shipbldg. and Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 455–456. Illustration of violent effects of faulty arrangement on teeth of gear wheels.

GEARS

Hydraulic-Power Transmission. Hydraulic Power Transmission Gears, M. H. Sabine. Practical Engr., vol. 65, nos. 1828, 1831, 1832 and 1833, Mar. 9, 30, Apr. 6 and 13, 1922, pp. 151–154, 205–206, 221–222 and 235–236, 8 figs. Mar. 9: Discusses variable power transmission by oil in which a prime mover revolving in one direction at constant speed is coupled direct to a variable-delivery pump which delivers oil to a fluid motor, usually of fixed capacity. Mar. 30: Working of gear and features of Carey pump. Apr. 6 and 13: Carey pump cylinder action; pulsations and vibration; success of Hele-Shaw gear.

Involute. The Involute Gear Tooth—XII, A. Fisher. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 55–58, 8 figs. Generation by pinions.

Latest Practice. Gear Makers' Convention of Much Technical Interest, P. M. Heldt. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 901–906, 5 figs. Papers presented on good hob practice, use of projection comparator in testing gear teeth, proportion of industrial gears, the grinding of gear teeth and new system of bevel gears.

One-Tooth Pinion. A Novel One-Tooth Pinion. Eng. Production, vol. 4, no. 82, Apr. 27, 1922, p. 396, 4 figs. Details of an interesting high-ratio gear.

Teeth Repairing. Repairing Broken Gear Wheel Teeth, G. H. Radebaugh. Brick & Clay Rec., vol. 60, no. 8, Apr. 18, 1922, pp. 617–620, 14 figs. Various styles of gears, four methods of repairing cast teeth, description of stud method which does not require commercial repair shop.

Worm-Reduction. Worm Reduction and Change-speed Gearing. Engineer, vol. 133, no. 3457, Mar. 31, 1922, pp. 352–354, 4 figs. Describes new invention the novelty of which consists of entire absence of usual spur wheels and use instead of worms and worm wheels.

GRINDING

Auger Bits. Auger Bit Grinding Operations, K. H. Lansing. Abrasive Industry, vol. 3, no. 5, May 1922, pp. 154–156, 7 figs. Wood boring augers and bits are finished almost entirely by manual operations involving solid and setup wheels.

GRINDING MACHINES

Planetary Spindle, with. Grinding Machine with Planetary Spindle, W. Pockrandt. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 88–91, 10 figs. How planetary spindle works. Grinding machines with vertical and horizontal grinding spindle. Comparisons between the two types of grinding machines.

GUN MOUNTS

Christie Motor Carriages. Christie Motor Carriages, H. E. Pengilly. Army Ordnance, vol. 2, no. 11, Mar.-Apr. 1922, pp. 285–290, 6 figs. Describes new tractor type of carriage developed to meet need for mobile artillery capable of high speed on good roads of present Army Transport, and of negotiating most difficult terrain encountered in field maneuvers.

H

HANDLING MATERIALS

Car Tipping in Factory Yards. Modern Appliances for Tipping Wagons in Factory Yards, E. Krahnen. Eng. Progress, vol. 3, no. 5, May 1922, pp. 111–113, 6 figs. Electrically operated tippers with toothed segments or traction ropes; double-end tippers; swinging tippers.

Electrical Plants. Modern Electrical Handling Plant, H. H. Broughton. Beama, vol. 10, nos. 3 and 4, Mar. and Apr. 1922, pp. 210–216, 8 figs., pp. 325–332, 3 figs. Mar.: Gives examples of various types of cranes and bridge transporters and discusses grain handling. Apr.: Canadian and South African grain-handling installations. Data on use of grabs to increase unloading of ore into Great Britain. Buying cargo cranes.

Internal, Textile Finishing Plant. Internal Transportation in a Large Textile Finishing Plant, A. Hamilton Church. Management Eng., vol. 2, nos. 4 and 5, Apr. and May 1922, pp. 197–202 and 293–296, 14 figs. Describes transportation methods of plant of The Mount Hope Finishing Co., Taunton, Mass.

Methods. Handling Material in the Steinway Factories, Paul Bulhuber. Management Eng., vol. 2, no. 5, May 1922, pp. 263–268, 10 figs. Methods used for raw materials parts, and finished products.

HEAT

Economical Use. Economical Use of Heat (Sparsame Temperaturwirtschaft), K. Schreber. Dinglers Polytechnisches Journal, vol. 337, nos. 6 and 7, Mar. 25 and Apr. 8, 1922, pp. 51–54 and 61–65, 4 figs. Discusses relation of value of unit of work and value of unit of heat, and gives various illustrations of boilers.

Conservation. Control of Heat Consumption (Ergebnisse der wärmetechnischen Betreibsüberwachung), H. Berner. Wärme (Zeit. für Dampfkessel u. Maschinenbetriebe), vol. 45, nos. 1 and 2, Jan. 6 and 13, 1922, pp. 6–9 and 30. Fundamentals of control; operating tests; measuring devices; loss and utilization of waste heat; the heat pump; waste energy; furnace and other losses; savings effected through control.

HEAT TRANSMISSION

Building Materials. Temperature Study in a Wall of Undefined Thickness Whose Faces are Subject to a Uniform Periodical Variation of Temperature (Étude du Régime des températures dans l'épaisseur d'un mur indefini dont les duex faces sont soumises à une même variation périodique de la température), (J. Seigle. Révue de l'Industrie Minérale, no. 30, Mar. 15, 1922, pp. 135–145, 11 figs. Mathematical paper on heat transmission and heat conductivity of materials such as brick.

HEAT TREATING

Gas Firing. Gas Wins Out for Heat Treating, J. P. Lafore. Gas Age-Rec., vol. 49, no. 15, Apr. 15, 1922, pp. 451–452 and 456, 3 figs. Describes gas equipment of eastern metallurgical plant which was installed after considerable experience with coal, electricity, oil and gas.

Mediums. Fuels, Burners, and Quenching Mediums for Heat-treatment, S. P. Rockwell. Machy. (Lond.), vol. 20, no. 500, Apr. 27, 1922, pp. 100–103, 3 figs. Advantages and disadvantages of different kinds of fuel, types of burners, and description of results obtained by various quenching baths.

HEATING

Flue-Gas Utilization for. The Heating of Factory Rooms and Halls through Utilization of Flue Gas (Neuzeitliche Grossraumheizung mittels Rauchgasausnutzung), Otto Brandt. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 4–6, 6 figs. Describes two systems and points out their advantages and economy.

HEATING, ELECTRIC

Losses. The Determination of Heat Loss, Walter W. Nobbs. Beama, vol. 10, no. 4, Apr. 1922, pp. 312–320, 2 figs. Fallacies in past heating determination in the formulas in coefficients and tables. Heating computations.

Residences, Tacoma, Wash. Electric Heating of Residences in Tacoma. Heat. & Vent. Mag., vol. 19, no. 4, Apr. 1922, pp. 41–45, 6 figs. Interesting features of installations in 795 residences, 54 apartments and 76 business and other buildings.

HEATING, HOT-AIR

Fan Furnace System. Fan Furnace Heating of a Theatre. Sheet Metal Worker, vol. 13, no. 6, Apr. 14, 1922, pp. 171–173, 5 figs. Describes heating and ventilating system of Rialto Moving Picture Theatre, Hamilton, Ohio, in which vertical sectional furnaces are used as air heaters, and fan is used to insure positive distribution and proper ventilation.

Leader Sizes, Figuring. Simplified Scientific Method of Figuring Leader Sizes, P. J. Dougherty. Sheet Metal Worker, vol. 13, no. 7, Apr. 28, 1922, pp. 209, 215. Two rules by which to determine heat losses from building as well as leader pipe sizes.

HEATING, STEAM

Central Stations. The Neukoelln Municipal Central Station for Distance Heating. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 77–78, 2 figs. At present 14 individual buildings or groups of buildings in a Berlin suburb are supplied with heat from this common source. Heating plant was designed and executed by Körting Bros., Berlin Branch. Required heat supply amounts to 5,800,000 kg-cal. per hr., and it is intended to enlarge station to max. heat output of 15,000,000 kg-cal. per hr.

Report on Experiments With a Coke Economizer of the Zuppinger Type by the Thermotechnical Division of the Union of Central Heating Stations (Bericht über die Versuche der wärmetechnischen Abteilung im Verband der Centralheizungs-Industrie mit dem Koksparer Bauart "Zuppinger"), A. Grossmann. Gesundheits-Ingenieur, vol. 45, no. 15, Apr. 15, 1922, pp. 193–201, 5 figs. Gives results of a number of evaporation tests confirming advantages of Zuppinger apparatus.

HELICOPTERS

Propeller Screws. Helicopters (Les hélicoptères), W. Margoulis. Aeronautique, vol. 4, no. 34, Mar. 1922, 16 pp. (supplement), 10 figs. Results of experiments carried out to determine mechanical functioning of propeller screws.

HIGHWAYS

Transportation Economics. Traffic Facts Shown by Highway Transportation Surveys. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 917–919, 1 fig. Overloading is prevalent in hauling all commodities. Trucks handle large percentage of manufactured products carried over route covered by surveys; 3.2 passengers per car is average determined; 2-ton trucks form 16 per cent of total. Census example of needed transport studies.

HOISTS

Portable Column. The Modern Column Hoist, F. A. McLean. Can. Min. Jl., vol. 43, nos. 11 and 12, Mar. 17 and 24, 1922, pp. 152–156 and 169–172, 15 figs. Mar. 17: Describes modern portable column hoist, its construction and use in mine and quarry operation. Mar. 24: Tugger slushing in metal and coal mines.

HOUSING

Location of Blocks of Dwellings. Location of Blocks of Dwellings by the Compass and Available Sunshine (Die Lagerung städtischer Wohnblocks zur Himmelsrichtung mit Rücksicht auf die Besonnungsverhältnisse), K. A. Hoepfner. Gesundheits-Ingenieur, vol. 45, nos. 12 and 14, Mar. 25 and Apr. 8, 1922, pp. 148–150 and 181–185, 14 figs. Shows by diagrams and curves amount of sunshine available during year for houses running east-west, north-south, northeast-southwest, etc.

HYDRAULIC MACHINERY

Engines. A New Hydraulic Engine (Eineneue

Wasserkraftmaschine "Aquapulsor"), R. Winkel-Glasers Annalen, vol. 90, no. 6, Mar. 15, 1922, pp. 92–97, 21 figs. Describes new type known as aquapulsor, and its use for irrigation and drainage, and for filling and emptying of navigation locks.

HYDRAULIC TURBINES

Large Installations. Some Large Turbine Installations in Austria and Other Countries (Einige grössere Turbinenanlagen in Oesterreich und im Ausland), W. Hahn. Elektrotechnik u. Maschinenbau, vol. 40, nos. 12 and 13, Mar. 19 and 26, 1922, pp. 133–139 and 147–149, 12 figs. History of development and examples of large turbine installations in America, Scandinavia, Japan, Germany, etc.

Molding 50-Ton Runner. Molding a 50-Ton Turbine Runner. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 318–321, 6 figs. Set of cores forming mold was assembled on an iron plate divided in two for convenience in setting last of vane cores.

HYDRODYNAMICS

Equations. Ambiguous Solutions of the Hydrodynamic Equations (Ueber mehrdeutige Lösungen der hydrodynamischen Gleichungen), George Jaffé. Physikalische Zeit., vol. 23, no. 6, Mar. 15, 1922, pp. 129–133, 4 figs. Presents example, similar to Villat example, of two-directional flow against a hollow space, thus forming a dead-water area of indeterminate size in the space.

HYDROELECTRIC DEVELOPMENTS

Belgium. Utilization of Belgian Hydroelectric Resources (Avant-Projet de captation des energies hydrauliques Belges), Herman Chauvin. Révue Universelle des Mines, vol. 11, nos. 1, 3, 4, 5, 6, Oct. 1, Nov. 1, 15, Dec. 1, 15, 1921, pp. 1–28, 261–277, 509–523, 629–644, 15 figs. on supp. plates. Oct. 1: Discusses general questions of river water supply and control for power purposes; and barrage work carried out in various rivers. Nov. 1: 15, Dec. 1 and 15: Describe work carried out on the Sambre and Meuse rivers.

Chippawa-Queenston. First 50,000 hp. Unit of Chippawa-Queenston Power Scheme. Elec. News, vol. 31, nos. 4, 5, 6, 7 and 9, Feb. 15, Mar. 1, 15, Apr. 1 and May 1, 1922, pp. 29–34, 28–33, 30–34, 27–34 and 32–35, 35 figs. Feb. 15: Series of articles describing work in connection with location of intake, canal and power house; also general design. Mar. 1: Details of hydraulic installation. Mar. 15: Excavation methods for moving 17,000,000 cubic yards of material and cutting through rock and earth; lining of canal; etc. Apr. 1: Design of power plant and specifications and installation of major apparatus May 1: Description of generators nos. 4 and 5 being completed by Can. Gen. Elec. Co.

Switzerland. The Silser Lake-Bergeller Power Plant Project (Die projektierten Silsersee-Bergeller Kraftwerke), Adolf Salis. Schweizerische Bauzeitung, vol. 79, no. 13, Apr. 1, 1922, pp. 161–164, 8 figs. Discusses present project for utilization of water power of Silser Lake in the Upper Engadine, Switzerland.

HYDROELECTRIC PLANTS

Germany. Supplying the Town of Passau with Electric Power and the Power Station Hals on the Ilz (Die Versorgung der Stadt Passau mit elektrischer Energie und das Kraftwerk Hals an der Ilz), Albert Sturm. Bauingenieur, vol. 3, no. 6, Mar. 31, 1922, pp. 170–173, 7 figs. Describes work of damming the Ilz and construction of buildings for machines; etc.

Italy. Thermoelectric Plant at Torre del Lago (Impianto termoelettrico di Torre del Lago Trazione elettrica). Revista Tecnica delle Ferrovie Italiane, vol. 21, no. 2, Feb. 15, 1922, pp. 33–42, 19 figs. Describes Italian thermoelectric plant worked under a concession supplying power to state railways, state participating in profits when over 7 per cent dividends are paid.

Norway. The Aust-Agder Power Station (Aust-Agder Kraftverk), Kr. T. Westbye. Elektrotecknisk Tidsskrift, vol. 35, no. 10, Apr. 5, 1922, pp. 73–76, 12 figs. Describes construction work and equipment, transmission lines, transformer stations, etc.

Switzerland. The Olten-Geosgen Hydroelectric Power Station (Centrale hydroélectrique suisse d'Olten-Goesgen), H. De Watteville. Houille Blanche, vol. 21, no. 174, Jan.-Feb. 1922, pp. 1–5, 5 figs. Describes construction work, including damming of the Aar; and equipment, including Brown-Boveri 7050 k.v.a. alternators at 7700–8400 volts, transformers, long-distance transmission at 70,000 volts.

I

ICE MANUFACTURE

Raw-Water Can System. Modern Systems for Manufacture of Raw Water Can Ice, Van Rensselaer H. Greene. Ice and Refrigeration, vol. 62, no. 4, Apr. 1922, pp. 287–288. Some details of method of obtaining clear ice by means of blowing air through it while freezing.

Sea Water. Using Sea Water in Ice Manufacture. Ice and Refrigeration, vol. 62, no. 4, Apr. 1922, p. 320. Experiments by Dyle and Bacalan demonstrating advantages of sea-water ice for some types of refrigeration.

ICE PLANTS

Electrically Operated. The Electrically Operated Ice Plant, H. J. Macintire. Ice and Refrigeration, vol. 62, no. 4, Apr. 1922, pp. 273–277. Some results of advance in use of electricity in last five years.

Japanese. A Japanese Ice Plant, L. H. Jenks, Jr. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 14–16, 8 figs. Recently completed installation on Island of Hikoshima for Imperial Ice Co.

INDICATORS

Optical. Optical Indicator. Eng. Progress, vol. 3, no. 5, May 1922, p. 114, 5 figs. Description of manograph indicator made by O. S. A. Apparatus Co. Ltd., based upon deflection of beam of light striking mirror by which it is reflected.

Planimetric. Planimetric Indicator (Planiketrierender Indikator), L. Gümbel. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 13, Apr. 1, 1922, pp. 298–299, 6 figs. Describes indicator developed by author, consisting of an indicator cylinder of usual dimensions with outside spring and without writing device. The gear is so arranged that the indicator records progressively.

INDUSTRIAL MANAGEMENT

Antagonism. The Inevitable Antagonism Between Employers and Employees. Management Eng., vol. 2, nos. 4 and 5, Apr. and May 1922, pp. 246–247, 308–309. Discussion by various authors of article by C. E. Knoeppel in March issue.

Charting, Authority and Responsibility. Charting Authority and Responsibility to Show Complex Management Relationships, Boyd Fisher. Management Eng., vol. 2, no. 5, May 1922, pp. 281–284, 2 figs. Lack of value of familiar organization charts and suggestions for an samples of worthwhile ones.

Cost-Control Committee. The Organization and Operation of the Cost Control Committee Plan, John H. Van Deventer. Indus. Management, vol. 63, no. 5, May 1922, pp. 267–272. Machinery of plant for building economic morale to reëstablish profit margins.

Cost Predetermination. The Determination of Costs, J. McD. Cronin. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 221–224. A system which will reveal true costs in time to control them.

Earnings, Interpreting Average. Interpreting Average Hourly Earnings on Semiautomatic Operations, Paul Faltin and Leon Blog. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 215–219, 1 fig. Adoption of piecework system of wage payment.

Executive Ability. Measuring Executive Ability, William E. Dunn. Indus. Management, vol. 63, no. 5, May 1922, pp. 292–295. Suggesting measure of value and deducing factors that compose it.

Foremen, Training. Foremen Training as a Factor in Cost Reduction, B. M. Nussbaum. Indus. Management, vol. 63, nos. 4 and 5, Apr. 1922, pp. 229–233, 297–302. Apr.: Analysis of lecture-class method, conference-discussion method and standard-group study course, and advantages and disadvantages of each. May: Means of getting and holding the foremen's interest.

Foundry Costs. Volumetric Efficiency as a Measure of Foundry Costs, Douglas T. Sterling. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 201–205, 3 figs. Relations between floor space, flask volume and weight of castings.

Happiness, Importance of. Making Happiness a By-Product of Industry, Geo. W. Hanley. Indus. Management, vol. 63, no. 5, May 1922, pp. 287–291, 8 figs. Restoring to business human interest and coöperation betwen employer and employee.

Incentives and Rate Setting. Incentives and Rate-Setting Applied to the Smaller Plant and Varied Product, E. Wadsworth Stone. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 205–208. Value of practical encouragement applied to smaller plant.

Production Cost Cutting. Cutting Production Costs by Combining Manufacturing Operations, C. B. Bartlett. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 198–200, 2 figs. Operations which can be combined substantially decreasing costs as well as reducing hazards.

Profits, Reëstablishing for Small Factory. Re-Establishing the Profits of the Small Factory, Ernest Cordeal. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 251–254. Importance of vesting authority to hire and discharge employees in special department.

Scope. Looking Management Engineering in the Eye, Erwin H. Schell. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 233–236. High standards, assimilating new ideas, an art as well as science; present day demands.

University Training in Factory. Taking University Training to the Factory, Paul M. Atkins. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 239–242, 1 fig. Plan to increase receptivity of working force to new ideas, train employees for advancement and discover those best fitted for promotion.

Wastes. Searching Out the Invisible Wastes, C. J. Morrison. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 196–197. Some prominent points of attack for cost cutting campaign.

[See also EXECUTIVES; SAFETY ENGINEERING; TIME STUDY; WASTE.]

INDUSTRIAL TRUCKS

Electric. Electric Vehicles. Gen. Elec. Rev., vol. 25, no. 4, Apr. 1922, pp. 200–259, 62 figs. Special issue containing articles by various authors on the battery vehicle in England; electric trucks in express service and in automotive field; electric passenger vehicle; operation; design and application of motors; controllers and resistances for storage-battery-driven vehicles; charging systems; advantages of gasoline and electric trucks with interchangeable parts; etc.

INSPECTION

Methods. Inspection Methods that have Proved Successful, H. Alton. Can. Machy., vol. 27, no. 17, Apr. 27, 1922, pp. 17–19 and 21. See that specifications are correct. Incoming material should be carefully inspected before going into stores. Where gaging is most effective. Coöperation of departments.

INSTRUMENTS

Precision. Practical Application of Precision Instruments, H. Alton. Can. Machy., vol. 27, no. 16, Apr. 20, 1922, pp. 24–26, 6 figs. Construction of different gages; improved design increases efficiency; reducing weight of larger sizes; combining blocks for checking dimensions; testing micrometers for wear.

INSULATION, HEAT

Thermoconductivity of. Heat Insulators. Refrig. World, vol. 57, no. 4, Apr. 1922, pp. 21–22. Abstract of special report of Food Investigation Board of G. B. on thermal conductivity of insulating materials usually employed.

INTERCHANGEABLE MANUFACTURE

Tolerance System. Tolerance System in Interchangeable Manufacture, C. W. Ham. Sibley Jl. of Eng., vol. 36, no. 4, Apr. 1922, pp. 66–67, 74. Definitions of terms; examples of their use; undesirability of specifying closer tolerances than necessary.

INTERNAL-COMBUSTION ENGINES

Alcohol for Fuel. Alcohol for Motor Fuel. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 364–365. Possibilities of more general use and points in favor of and against it.

Castings. Castings for Internal Combustion Engines, Ben Shaw and James Edgar. Foundry Trade Jl., vol. 25, no. 293, Mar. 30, 1922, pp. 236–239, 14 figs. Discusses production of pistons, their heat treatment and molding details. Also discusses castings for crank-case bottom, water inlet, front cover, and gear boxes.

Combustion Process. Combustion Process in Explosion Engines (Forbraendingsprosesser i eksplosjonsmotorer), W. Holwech. Teknisk Ukeblad, vol. 69, nos. 9, 10 and 12, Mar. 3, 10 and 24, 1922, pp. 78–80, 87–91 and 116–118, 12 figs. Mar. 3: Mixing of gases; compression; ignition; combustion; expansion. Mar. 10: Discusses velocity of propagation of combustion, limits of explosions, and gives curves for various combustibles, such as methane, ethane, water gas, acetylene, etc. Mar. 24: Discusses results of new investigation, including heat of combustion and heat balance.

Cooling. Improvements in the Cooling of Internal-Combustion Engines (Neuerungen in der Kühlung der Verbrennungsmotoren), H. Praetorius. Motorwagen, vol. 25, no. 9, Mar. 31, 1922, pp. 165–171, 12 figs. Discusses recent patents on the subject.

Design. Modern Tendencies in Internal-Combustion Engine Construction (Tendances modernes dans l'étude et la construction des moteurs), Edmond Bruet. Outillage, Tome 251, 252 and 253, nos. 11, 12 and 13, Mar. 18, 25 and Apr. 1, 1922, pp. 326–328, 353–356 and 374–377, 23 figs. Mar. 18: Combustion of gaseous mixtures; propagation of flame. Mar. 25: Kerosene, in internal-combustion engines (Bellem and other engines). Apr. 1: Deals with Diesel engines. Construction and operation of Sulzer two-stroke engine, the Ruston high-pressure engine, and compound Diesel engine.

Friction Losses. Friction Losses in Internal-Combustion Engines (Étude des pertes par frottements dans les moteurs à combustion interne), André Planiol. Comptes Rendus des Séances de l'Académie des Sciences, vol. 174, no. 13, Mar. 27, 1922, pp. 860–863. Gives results of experiments with four-stroke single-cylinder engine running on town-gas and develops formula for friction.

Fuel-Introduction Systems. Fuel Introduction Systems for Internal Combustion Engines. Pacific Mar. Rev., vol. 19, no. 5, May 1922, pp. 285–286, 9 figs. Description of high-pressure system developed for use with engines using accumulated type of fuel injection.

Molecular Movements During Combustion. Molecular Movements During Combustion in Closed Systems, Thomas Midgley, Jr. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922 pp. 357–361 and (discussion) 362–363, 11 figs. Theoretical analysis of experimental work of Woodbury, Canby & Lewis published in Mar. 1921 Jl.

Photographic Recording of Data. Photographic Recording of Engine Data, Augustus Trowbridge. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 351–356, 368, 12 figs. Outline of history of photographic recording apparatus and description of how it can be used to overcome difficulties with ordinary indicated diagrams.

Research. Recent Research Work on the Internal-Combustion Engine, Harry R. Ricardo. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 305–328 and (discussion) 328–336 and 347, 42 figs. Discussion of fuels as to mean volatility, detonation, turbulence, stratification, and comment on benefits of weak fuel mixtures.

Still System. The Still System of Internal Combustion, F. Leigh Martineau. Can. Shipg. & Mar. Eng. News, vol. 12, no. 4, Apr. 1922, pp. 17–19. Shows that Still system can be applied to any type of internal-combustion engine without any radical alteration. Mechanical features also dealt with.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; MARINE ENGINES; SEMI-DIESEL ENGINES.]

IRON

Melting, German Practice. Melting Iron in a German Foundry, Hubert Hermanns. Foundry, vol. 50, no. 9, May 1, 1922, pp. 367–370, 7 figs. Elabo-

rate equipment and precautions to insure suitable metal characterize methods of big Rhineland cylinder plant. Cast cylinders for original Otto gas engine.

IRON AND STEEL

Gases in. Determination of Gases in Iron and Steel (Bestimmung der Gase in Eisen und Stahl), A. Vita and Eduard Maurer. Stahl u. Eisen, vol. 42, no. 12, Mar. 23, 1922, pp. 445–452 and (discussion) pp. 452–456, 3 figs. Two reports from Chemical Committee of Assn. German Iron Met. Engrs. on process for determination of gases by means of chemical changes; and comparison of results with those obtained in extraction process by physical means.

Properties and Uses. Iron and Steel Classified for Designers, Wm. J. Merten. Blast Furnace & Steel Plant, vol. 10, no. 4, Apr. 1922, pp. 230–234, 12 figs. Survey of wrought iron, malleable iron, cast iron, and semi-steel, with special reference to physical properties, characteristics, uses and heat treatment.

IRON CASTINGS

Engines. Engine Castings Requirements Rigid, H. J. Young. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 311–314, 18 figs. Micrographs show variation in iron in same castings; heat tends to cause Diesel-engine cylinder liners and pistons to grow: study of requirements urged. (Abstract.) Paper read before British Inst. Mar. Engrs.

Liquid Fracture in. Liquid Fracture in Iron Castings, S. G. Smith. Foundry Trade Jl., vol. 25, no. 296, Apr. 20, 1922, pp. 283–285, 7 figs. An occurrence which takes place in a casting before whole of casting has become solidified, sometimes being only microscopic and sometimes so large that it separates casting in two pieces.

IRON, PIG

Casting Methods. Questions Pig Iron Casting Methods, Robert E. Newcomb. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 316–317. Advantages and disadvantages for foundry use of sand-cast pig iron, compared with those of pig iron made by machine casting process.

L

LAPPING

Hand and Machine. Hand and Machine-lapped Surfaces as seen through a Microscope. Machy. (Lond.), vol. 20, no. 500, Apr. 27, 1922, pp. 113–114, 6 figs. Comparison of two types of finish magnified 220 times.

LIGHTHOUSES

Aerial. Powerful Lighthouses in Aerial Navigation (Les phares à grande portée en navigation aérienne), A. Volmerange. Aeronautique, vol. 4, no. 34, Mar. 1922, pp. 67–74, 7 figs. Development of marine lights and lenses; principles of new powerful aerial lights, such as Barbier-Bénard and Sautter-Harlé-visibility of light; etc.

LIGHTING

Effective, Planning and Installing. Planning and Installing Effective Lighting, John. T. Scott. Can. Machy., vol. 27, no. 16, Apr. 20, 1922, pp. 19–20, 2 figs. Suggestions on distribution, adapting existing equipment, and reflecting surfaces by engineer in charge of standardization work at Sunbeam Lamp Wks.

Industrial. Choice of Fixtures for Industrial Lighting, John T. Scott. Can. Machy., vol. 27, no. 17, Apr. 27, 1922, pp. 20–21, 3 figs. Type of reflector depends on work. Softening shadows and eliminating glare. Keep globes and lamps free from dirt. Good light prevents accident.

LIGNITE

Burning on Chain Grates. Burning Canadian Lignite on Chain Grates. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 27–28, 2 figs. Mention of several installations of Saskatchewan and Manitoba districts in which satisfactory results have been obtained. Describes typical furnace arrangement.

Deposits and Industries. Lignites and Brown Coals and Their Importance to the Empire, William Arthur Bone. Royal Soc. Arts Jl., vol. 70, no. 3619, Mar. 31, 1922, pp. 342–355 and (discussion) 355–359, 1 fig. Origin and classification, characteristics and properties; geographical distribution; brown-coal industries in various countries.

Drying. Drying of Brown Coal for Boilers and Furnaces (Rohbraunkohletrocknung für Dampfkesselfeuerungen und industrielle Oefen), W. Viebahn. Braunkohle, vol. 20, no. 51, Mar. 25, 1922, pp. 801–805, 1 fig. Discusses heat loss due to water content in brown coal and preheating of brown coal to deprive it of its water.

Gasification. Past Efforts and Future Prospects in Lignite Gasification for the Heating of Open-Hearth Furnaces (Die bisherigen Bestrebungen und die zukünftigen Aussichten der Braunkohlenvergasung für die Beheizung von Siemens-Martinöfen), Hubert Hermann. Braunkohle, vol. 20, nos. 22 and 23, Sept. 3 and 10, 1921, pp. 337–341 and 358–362, 8 figs. Economic and technical aspects of lignite gasification.

LOCKS

Manufacture. The Mechanical Principles of Modern Locks and a Consideration of their Manufacture. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 49–54, 12 figs. Combined lever and warded lock, with double locking bolt; function of wards and levers; automatically operated deadlock; double keyhole locks; etc.

LOCOMOTIVE BOILERS

Design. Designing Locomotive Boilers for Maximum Efficiency, J. T. Anthony. Boiler Maker, vol. 22, no. 4, Apr. 1922, pp. 107–108. Air and gas areas and ratio of tube length to diameter important factors to be considered.

Standard for 2-8-0 Type. Standard Boiler for 2–8–0 Type Mixed Traffic Locomotives, Great Western Railway. Ry. Gaz., vol. 36, no. 14, Apr. 7, 1922, pp. 600–601, 3 figs. Has coupled wheels 5 ft. 8 in. in diam.; boiler is No. 7 Swinton type; barrel tapers from 6 ft. diam. outside at throat plate to 5 ft. 6 in. diam. outside at smokebox; length of barrel, 14 ft. 10 in.

Tubes. Installing and Maintaining Charcoal Iron Locomotive Tubes, G. H. Woodroffe and C. E. Lester. Boiler Maker, vol. 22, no. 4, Apr. 1922, pp. 102–106, 13 figs. Use of welding in tube work and proper methods to be followed in maintenance and repair.

LOCOMOTIVES

Baldwin 2-8-0. "Consolidation" Locomotives for the Andalusian Railway, Spain. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, pp. 553 and 556, 2 figs. Describes new Baldwin 2–8–0 type locomotive, which has unusually low coal consumption.

British and American Practice. British and American Locomotive Practice. Ry. Engr., vol. 43, no. 507, Apr. 1922, pp. 126–127. Abstract of paper presented at recent meeting of I.M.E. by P. C. Dewhurst, Loco., Carriage, and Wagon Supt. of Jamaica Govt. Rys. Closely reasoned comparisons and criticisms well worth considering.

Compound 2-8-0. New 2–8–0 Type Compound Locomotives for the Buenos Ayres Western Railway. Ry. Gaz., vol. 36, no. 16, Apr. 21, 1922, p. 676, 1 fig. Description of two-cylinder compound engine.

Design. Modern Tendencies in Locomotive Design, James Partington. Ry. Age, vol. 71, no. 15, Apr. 15, 1922, pp. 909–910 (includes discussion). Need of increased economy in use and production of steam; possibility of turbine and internal-combustion locomotives. (Abstract.) Paper presented at Newport News meeting of Am.Soc.Mech.Engrs.

Drifting Valve. Roberts Automatic Drifting Valve. Ry. & Locomotive Eng., vol. 35, no. 4, Apr. 1922, pp. 94–95, 2 figs. Object of valve is to automatically open small flow of steam to engine cylinders when throttle valve is closed, and to utilize exhaust of stoker and air pump for filling main engine cylinders as well as oil that has been fed to these auxiliaries for lubrication of cylinders.

Freight, Maximum Pull. Maximum Pull of Freight Locomotives (Essai sur les remorques maxima des locomotives à marchandises), L.-E. Creplet. Annales des Travaux Publics de Belgique, vol. 23, Feb. 1922, pp. 7–30. Describes tests with Pienlo locomotives on Kaifeng-Loyang line in China, including resistance at starting, effect of curves, etc.

Gasoline. A Gasoline Locomotive (Une locomotive a essence). Ach. Delamarre. Outillage, vol. 252, no. 12, Mar. 25, 1922, pp. 359–360, 2 figs. Describes new Renault locomotive for shunting and similar purposes in factories.

Lentz Hydraulic Transmission. "Lentz" Hydraulic Transmission for Crude-Oil Locomotives, Wittfeld. Eng. Progress, vol. 3, no. 5, May 1922, pp. 105–108, 4 figs. Internal-combustion engine burning heavy crude oil is to be adapted for locomotive service by means of Lentz hydraulic transmission. First crude-oil locomotive on this system has just been put in commission. Results of trials with this locomotive.

Steam-Electric Condensing-Turbine. New Development in Locomotive Practice. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, pp. 557 and 564, 4 figs. partly on p. 558. Describes Ramsay condensing-turbine electric locomotive, built by Armstrong, Whitworth & Co., Ltd., tractive force, 22,000 lb.

Thermic Siphons. Thermic Syphons Save 19 Per Cent in Fuel. Ry. Age, vol. 72, no. 16, Apr. 22, 1922, pp. 977–978, 1 fig. Improved performance of ten-wheel locomotive enables Spokane International to haul heavier trains.

Test of Syphon-Locomotive on Spokane International Ry. Ry. Rev., vol. 70, no. 15, Apr. 15, 1922, pp. 522–524, 3 figs. Application of single thermic siphon enables increase in tractive effort and improves efficiency of locomotive.

Valve Gear. The Calculation and Graphical Representation of the Walschaerts Valve Gear for Locomotives, S. E. W. Westrén-Doll. Ry. & Locomotive Eng., vol. 35, no. 4, Apr. 1922, pp. 88–92, 10 figs. Describes valve and method of calculating its proportions.

The Young Locomotive Valve Gear. Ry. Jl., vol. 28, no. 4, Apr. 1922, pp. 16–21, 13 figs. Notes on original and subsequent applications, and part this valve gear is playing in successful operation on railways in United States, Canada and Mexico in passenger, freight and switching service.

LUBRICATING OILS

Crankcase Oil Dilution. Crankcase Oil Dilution Problem and Its Solution, William F. Parish. Eng. World, vol. 20, no. 5, May 1922, pp. 307–314, 11 figs. Effect upon viscosity of lubricant; viscosity limits for lubricating oils established; relation between viscosity of lubricant and efficiency of engine shown graphically in tabular form. See also Oil News, vol. 10, no. 9, May 5, 1922, pp. 33–34 and 44–46, 1 fig.

Reconditioning Crankcase. Reconditioning Crankcase Lubricating Oil by a New Method. Automotive Industry, vol. 46, no. 17, Apr. 27, 1922, pp. 910–911, 3 figs. Fuel diluent and water automatically removed from crankcase lubricating oil by simple refiner which also filters out sediment.

LUBRICATION

Uniflow Engine. Lubrication of the Uniflow Engine. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 477–479. Some of features which make lubrication different for this type of engine and suggestions for proper solution. (Abstract.) Lubrication, pub. by Texas Co.

M

MACHINE GUNS

Barrels, Life of. Life of Machine-Gun Barrels, W. W. Sveshnikoff. Army Ordnance, vol. 2, nos. 9 and 11, Nov.-Dec. 1921 and Mar.-Apr. 1922, pp. 161–165 and 304–307 and 316, 24 figs. Nov.-Dec.: Abrasive action of bullet and gases. Principal factors which affect life of a machine gun. Mar.-Apr.: Cracking of surface of bore. Extracts from Technologic Papers Bur. Standards, No. 191.

Carriages and Mountings. Ordnance and Machine-Gun Carriages and Mountings. Abridgments of specifications, Period 1909–15, Class 92 (i), 1922, 277 pp. Patents for inventions.

MACHINE SHOP

Field Shop. A Field Shop in the Oil District, Frank A. Stanley. Western Machy. World, vol. 13, no. 4, Apr. 1922, pp. 120–122, 8 figs. Description of well-equipped shops maintained in Signal Hill Oil fields by Shell Co.

MACHINE TOOLS

Chain Drive. The Chain Drive and Machine Tools, Hubert Bentley. Mech. World, vol. 71, nos. 1838 and 1839, Mar. 24 and 31, 1922, p. 215 and pp. 235–236, 3 figs. Mar. 24: Compares chain with belt and gear drives; advantages of chain drive. Mar. 31: Types of chains and wheels; chain driving and installation and maintenance of chain drives.

German Construction. Progress in German Machine-Tool Construction (Fortschritte im deutschen Werkzeugmaschinenbau), Werner v. Schütz, G. Schlesinger and Max Kurrein. Werkstattstechnik, vol. 16, nos. 4a and 5, special no. and Mar. 1, 1922, pp. 1–62 and 129–156, 121 figs. Metal-working machines, including lathes, grinding, planing and slotting, boring and milling machines. Mar. 1: Hammers, shears, presses, bending machines and saws. Woodworking machines. Special machines. Tools, devices and finishing processes.

MALLEABLE IRON

Structure. Structure of White-Heart Malleable, Rudolph Stotz. Foundry, vol. 50, no. 7, Apr. 1, 1922, pp. 286–290, 25 figs. Principal characteristics shown by micrographs which indicate over or under annealing; carbon contents determine structure of unannealed iron.

MARINE BOILERS

Economy. Possibilities of Further Economy in Marine Boilers, John Reid. Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 461–465, 7 figs. Suggestions of remedies for heat losses and result of boiler trials at St. Peters Works, Hawthorne, Leslie & Co.

Possibilities of Further Economy in Marine Boilers, John Reid. Steamship, vol. 33, no. 395, May 1922, pp. 365–368, 4 figs. Data acquired from instruments installed in steamers suggests possibilities of new economies. Paper read at Spring Mtg. of Inst. of Naval Architects.

MARINE ENGINES

Sulzer Two-cycle. The Sulzer Two-Cycle Marine Engine, L. J. Le Mesurier. Oil Eng. & Finance, vol. 1, no. 2, Mar. 25, 1922, pp. 372–373. Advantages of two-cycle type above 1000 b.hp. (Abstract.)

MARINE STEAM TURBINES

Economy. Modern Marine Steam Turbine Economy. Mar. Engr. & Naval Architect, vol. 45, no. 535, Apr. 1922, pp. 165–167, 4 figs. Land and marine turbines compared. Direct drive versus reduction-geared turbines. Effect of higher gearing ratio and increased turbine revolutions on efficiency.

MATTER

Molecules, Space Between. The Space Between Molecules (Ueber den Abstand der Molekeln), Richard Gans. Physikalische Zeit., vol. 23, no. 5, Mar. 1, 1922, pp. 108–113, 4 figs. Derivation of equations for determining average space between molecules.

MEASURING INSTRUMENTS

Aircraft. Aircraft Measuring Instruments (Messgeräte für Flugzeuge), E. Everling and H. Koppe. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 13, Apr. 1, 1922, pp. 322–326, 29 figs. Points out that vibrations, quick change of flight and air conditions, and effect of wind necessitate special arrangement and construction of instruments, which is demonstrated by examples of indicating and recording instruments for pressure, change of altitude temperature, and for inclination and turning speed

Precision. Precision Work in the National Physica Technical Institute (Die Feinmechanik in der Physikalischen-Technischen Reichsanstalt), F. Göpel. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 13, Apr. 1, 1922, pp. 293–298, 5 figs. Review of work in laboratory for precision measuring, with special regard to technically important work. Deals with equipment and measuring methods. especially of technical gage blocks, pass bolts and gages, guide screws and standard threads, revolution counters, tuning forks, etc.

METAL SPRAYING

Schoop Process. Metal Spraying, An Anti-Rust Prophylactic. Raw Material, vol. 5, no. 4, May 1922, pp. 147–149, 4 figs. By Schoop process iron, steel, and non-metallic materials are given non-ferrous metal coatings through device resembling machine gun that bombards objective surface with minute plastic particles of metal.

METALS

Protection from Air and Heat. Protecting Metal From Air and Heat—Calorizing (La protection des metaux contre les agents atmospheriques et la chaleur—La calorisation ou protection par l'aluminium), R. Levatel. Outillage, vol. 254, no. 14, Apr. 8, 1922, pp. 412–413. Reviews the Bower-Barff, Gesner, Lohman, Schoop and sherardizing processes. Bibliography.

Polishing. Motion Study in Metal Polishing, E. Farmer and R. S. Brooke. Metal Industry (N. Y.), vol. 20, no. 4, Apr. 1922, pp. 133–136, 3 figs. Experiment with wattmeter on process of roughing.

Tempering. The Tempering Phenomena and Their Generalization (Les phénomenes de trempe et leur généralisation), De Perdiguier. Chimie et Industrie, vol. 7, no. 2, Feb. 1922, pp. 211–243, 32 figs. Discusses critical points in temperature diagrams, including the cases of, eutectoids, line of transformation separating zone of one constituent from zone of two constituents, and zone of two constituents with two irregular lateral boundaries.

Tempering Phenomena and Their Generalization (Les phénomènes de trempe et leur géneralisation), Léon Guillet. Révue de Métallurgie, vol. 19, no. 3, Mar. 1922, pp. 162–168, 13 figs. On basis of diagram discusses the three cases of (1) eutectoid, (2) line of transformation separating zone of one constituent from zone of two constituents, and (3) zone of two constituents bounded laterally by two irregular lines.

MILLING MACHINES

Vertical, Economy of. Examples Where Vertical Milling Saved Money, J. H. Moore. Can. Machy., vol. 27, no. 16, Apr. 20, 1922, pp. 17–18, 46, 5 figs. Suitable fixtures facilitate production; multi-tooth cutters replace single point tool; particularly adapted to die-sinking; special attachments for continuous milling.

MOLDING MACHINES

Portable Hand-Operated. Exhibits a German Molding Machine. Foundry, vol. 50, no. 8, Apr. 15, 1922, pp. 324–325, 5 figs. Describes portable, hand-operated machine of Vereinigte Schmirgel & Maschinenfabriken, A. G., recently exhibited at Liege, Belgium.

MOLDING METHODS

Production. Fittings Made on Production Basis. Foundry, vol. 50, no. 9, May 1, 1922, pp. 359–365, 9 figs. Adoption of simple and precautionary molding devices in shape of lifting plates and core prints reduce molding costs and insure more uniform product.

MOLYBDENUM STEEL

Automotive Industry. Use of Molybdenum Steel in the Automotive Industry, John D. Cutter. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 340–342 and (discussion) 342–344 and 347, 2 figs. Advantages in connection with light-weight car including reports and statements of metallurgists and manufacturers.

MONEL METAL

Properties and Uses. Monel Metal, a Natural Nonferrous Alloy, Morris A. Hall. Brass World, vol. 18, nos. 3 and 4, Mar. and Apr. 1922, pp. 76–79, 107–111, 18 figs. Appearance and properties; proper methods of melting and casting; uses and advantages.

MOTOR BUSES

Easy-Riding Tires. Easy Riding on Heavy Motor Vehicles. Bus Transportation, vol. 1, no. 5, May 1922, pp. 277–280, 15 figs. How tire and felloe construction provide comfort for passengers and longer life for bus mechanism.

High-Speed Design. High-Speed 'Bus Design. Motor Transport, vol. 34, no. 895, Apr. 24, 1922, pp. 500–501, 5 figs. Unusual body and chassis features embodied in vehicle built for Inter-city work in California, where high speeds are possible.

Trolley. Some Details of the "Rail-less" Car. Bus Transportation, vol. 1, no. 5, May 1922, pp. 268–269, 5 figs. Two-motor trolley bus with series-parallel control, seating capacity is thirty persons, with provision for liberal space and conveniences for several standees.

Trolley Bus Line Material and Current Collectors, G. W. Bower. Bus Transportation, vol. 1, no. 5, May 1922, pp. 281–282, 6 figs. Result of experience shows that design of suspension and collectors must coördinate.

MOTOR TRUCKS

Gas Producers. The Cazes Gas Producer for Motor Trucks (Le gazogène "Cazes" pour camion automobile), E. Weiss. Nature, no. 2501, Mar. 11, 1922, pp. 145–147, 3 figs. Describes producer-gas generator of 30–40 hp. consuming 483 gr. charcoal per hp. and pulling trucks of nearly 12 tons.

Tipping. New Motor Trucks for Conveying Quantity Goods (Neuere Lastkraftwagen für die beförderung von Massengütern), L. Ptaczowsky. Allgemeine Automobile Zeitung, vol. 23, no. 9, Mar. 4, 1922, pp. 38–40, 9 figs. Describes various types of Krupp tipping trucks; unloading sideways, on all sides, into railroad cars; etc.

MOTORCYCLES

Engines. Motor Cycle Engines. Automobile Engr., vol. 11, nos. 154 and 155, Sept. and Oct. 1921, pp. 299–300, 10 figs. and pp. 353–355, 4 figs. Sept.: Describes power units of Indian "Scout" Engine built by Hendee Mfg. Co. Oct.: Power units of J. A. Prestwich single cylinder and twin engines.

Single Sleeve-Valve Engine. The Barr and Stroud 3 Hp. Cycle Engine. Automobile Engr., vol. 12, no. 162, Apr. 1922, pp. 115–117, 7 figs. Features of recently developed Knight type motor.

N

NATURAL GAS

Combustion Tests. Natural Gas Combustion Tests, I. V. Brumbaugh and G. W. Jones. Gas Age-Rec., vol. 49, no. 16, Apr. 22, 1922, pp. 495–498, 2 figs. Associate Gas Engr. and Asst. Chemist of U. S. Bur. of Standards give, with permission, advance information on their tests of natural gas used in domestic gas burners.

NICKEL ALLOYS

Cooperite. Cooperite, a High-Speed Cutting Material. Raw Material, vol. 5, no. 3, Apr. 1922, pp. 110–112, 4 figs. Discusses properties of and tests made with cooperite, a non-ferrous alloy containing nickel as basic metal with various amounts of zirconium, aluminum, silicon, tungsten and molybdenum.

Nickel-Silver. Some Mechanical Properties of the Nickel-Silvers, F. C. Thompson and Elwin Whitehead. Metal Industry (Lond.), vol. 20, nos. 11 and 12, Mar. 17 and 24, 1922, pp. 249–254 and pp. 276–277 and (discussion) p. 280, 17 figs. Effect of conditions of annealing on tensile properties of hard-rolled alloys; temperature of heating and rate of cooling of three alloys containing 10, 15 and 20 per cent of nickel; results of tests. Paper read before Inst. Metals.

NOTCHED-BAR TESTS

Investigation of. The Notched-Bar Test (Die unerforschte Kerbschlagprobe), R. Stribeck. Stahl u. Eisen, vol. 42, no. 11, Mar. 16, 1922, pp. 405–408, 1 fig. Desiderata for new development. Notched-bar test for testing of workshop material. Author advises precaution in judging materials tested in this manner. Suggestions for a new regulation.

O

OIL FUEL

Laundry Power Plant. Oil Burning in Laundry Power Plant, Charles L. Hubbard. Nat. Engr., vol. 26, no. 5, May 1922, pp. 192–196, 9 figs. Oil substituted for coal and shows decided advantages; equipment details.

Naphtha, Calorific Power of. Indirect Determination of Calorific Power of Naphtha as a Fuel (Determinazione indiretta del potere calorifico della nafta per uso di combustibile), Giulio Morpurgo. Giornale di Chimica Industriale ed Applicata, vol. 4, no. 1, Jan. 1922, pp. 15–17. Discusses new method for analyzing liquid fues, which requires no complicated apparatus, and gives rational basis for evaluating naphtha.

Pools, Beds, or Streams. Pools or Beds, Streams of Oil? J. von Gal Scale. Petroleum Times, vol. 7, no. 172, Apr. 22, 1922, p. 560. Pointing out misleading character of term pool.

OIL INDUSTRY

Bergin Treatment. The Bergin Treatment of Mineral Oils and Coal, F. Bergin. Petroleum Times, vol. 7, no. 172, Apr. 22, 1922, p. 546. Description of process by which mineral oils and coal can be converted into benzine, motor spirit, and fuel oil. Presented at Assn. of German Chemists' recent meeting.

OILS

Specifications for Fats and. Oils, Fats, Lubricants, Candles, and Soaps. Abridgments of Specifications, Period 1909–15, Class 91, 1922, 151 pp. Patents for inventions.

OPEN-HEARTH FURNACES

Operation. Efficient Arrangement of Open Hearth Labor, P. S. Young. Blast Furnace & Steel Plant, vol. 10, no. 4, Apr. 1922, pp. 215–219. Reduction of forces by better distribution of men and occupations in operating modern open-hearth shop.

Valves, Reversing. New Reversing Valves for Open Hearth Furnaces, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 10, no. 4, Apr. 1922, pp. 228–229, 4 figs. Describes new bell valve, consisting of two parts which are separated by water-cooled partition wall.

OXY-ACETYLENE WELDING

Railway Shops, in. The Oxy-Acetylene Process in Railway Shops, F. S. Tinder. Car Foremen's Assn. of Chicago. Official Proc., vol. 17, no. 6, Mar. 1922, pp. 16–39 and (discussion) pp. 40–57, 2 figs. Notes on properties of acetylene and oxygen; development of process. Experience in welding on Virginian railway.

Safe Handling. Gas Welding and Cutting. Am. Gas Jl., vol. 116, no. 14, Apr. 8, 1922, pp. 328–330 and 336–338. Rules for safe handling of apparatus.

P

PAINTS

Protection for Wood. Paint Protection for Wood, Cornelius R. Myers. Soc. Automotive Engrs. Jl., vol. 10, no. 5, May 1922, pp. 348–350, 2 figs. Report of investigation resulting from complete lack of data on protection of wood against moisture.

Specifications. Why Paint Specifications Present a difficult Problem, F. P. Ingalls. Ry. Rev., vol. 70, no. 17, Apr. 29, 1922, pp. 597–600, 1 fig. Effect of character of pigment on drying and durability of paint; effect of size and shape of pigment particles on character of paint. Satisfactory specifications cannot be based on composition but on what paint will do. From paper presented at Nat. Exposition of Chem. Industries, in N. Y.

PAPER MANUFACTURE

Deodorizing Digester Blow. Removal of Odors from Digester Blow in Sulphate Mills, Gustaf F. Enderlein. Paper Mill, vol. 45, no. 16, Apr. 29, 1922, pp. 4, 1 fig. Suggestions as to means of avoiding poluting atmosphere by condensing odoriferous steam.

Developments. Recent Developments in Papermaking, T. D. Nuttall. Paper, vol. 30, no. 6, Apr. 12, 1922, pp. 7–11 and 16. Forming sheet and felting fibers on high speed machines of great width. From Proc. Technical Section of Papermakers' Assn. Great Britain and Ireland.

Explosion of Drying Cylinder. Explosion of a Drying Cylinder (Zerknall eines Trockenzylinders). Zeit. des Bayerischen Revisions-Vereins, vol. 26, no. 7, Apr. 15, 1922, pp. 51–52, 4 figs. Describes explosion at cellulose factory in Silesia; cylinder was part of a paper-making machine running 300 days of 24 hr. per year; exact cause has not been ascertained.

Latex. Making Paper with Latex, Frederick Kaye. Rubber Age, vol. 3, no. 2, Apr. 1922, pp. 67–68. Comparison of quality of product with and without this rubber derivative.

PAPER MILLS

Ventilation. Moving Air in Paper Mill Work, Paper, vol. 30, nos. 4, 5 and 7, Mar. 29, Apr. 5 and 19, 1922, pp. 7–11, 8–11 and 128–131. Mar. 29: Altering pressure of air; overcoming moisture from wet machines; types of finishing rooms to be ventilated; maintaining even humidity conditions; heating system for machine room; distributing the air. Apr. 5: Utilization of waste heat; use for air in plants making coated paper; regulating temperature of press rooms. Apr. 19: Methods of conditioning gummed paper; dryers; conditioning air in storage buildings.

PATENT LAWS

Germany. Inventions and Patent Rights (Maschinenerfindungen und Patentrecht). Dinglers polytechnisches Journal, vol. 337, no. 7, Apr. 8, 1922, pp. 65–66. Discusses requirement of novelty for German patents as laid down by recent legal decisions.

PATTERNS

Foundry, Design. Pattern Design Presents Problems, Joseph Horner. Foundry, vol. 50, nos. 7 and 8, Apr. 1 and 15, 1922, pp. 275–278 and 326–328, 25 figs. Apr. 1: Coöperation between heads of manufacturing enterprise will prevent annoying and costly mistakes. Apr. 15: Pattern construction costs from pattern-shop viewpoint and from foundry and machine-shop viewpoint.

PIPE

Threading and Cutting Machine The Landis Twelve-Inch Pipe Threading and Cutting Machine. Ry. & Locomotive Eng., vol. 35, no. 4, Apr. 1922, pp. 83–85, 6 figs. Length of machine is 11 ft., its extreme width, 5 ft. and it weighs 13,000 lb.; it has single-pulley drive, and variations in speed, which are eight in number, are obtained by means of speed box, located beneath main spindle.

PIPING

Losses, Calculation of. Calculating Losses in Air and Steam Conduits According to New Research on the Coefficient of Resistance to Flow (Calcul des pertes de charge dans les conduites d'air de vapeur et d'eau d'après de nouvelles recherches sur le coefficient de résistance à l'écoulement), V. Leveau. Révue Universelle des Mines, vol. 12, no. 4, Feb. 15, 1922, pp. 301–327, 10 figs. partly on supp. plate. Reviews literature on subject, calculates pressure losses, classifies pipe by roughness, and gives examples of applying new formulas.

PISTONS

Aluminum Alloys for Motor. Some Experiences of Aluminium and Its Alloys for Motor Pistons. Metal Industry (Lond.), vol. 20, no. 14, Apr. 7, 1922, p. 321. Advantages obtained from pistons of this type and analyses of more suitable combinations.

Cast Iron, Production. Methods Used in Specialized Production of Cast Iron Pistons, J. Edward Schipper. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 914–916, 6 figs. Some original processes. Foundry cores are machine-made. Description of aging process, machining and inspection methods. Claimed that pistons are held to tolerance of plus or minus 0.0005 in.

PLANERS

Spur-Gear. Planing Large Spur Gears. Machy. (Lond.), vol. 20, no. 498, Apr. 13, 1922, pp. 37–39, 5 figs. Application of gear planers which cut gear teeth by reproducing shape of a templet.

PLATES

Deflection. The Deflection of Continuous Plates and the Rectangular Plate with Free Edges (Ueber die Biegung durchlaufender Platten und der rechteckigen Platte mit freien Rändern), A. Nádai. Zeit. für angewandte Mathematik u. Mechanik, vol. 2, no. 1, Feb. 1922, pp. 1–26, 24 figs. Calculations to determine singularities of plate deflection.

POWER PLANTS

British Practice. Notes on British Power Plant Practice, C. H. S. Tupholme. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 416–418. Experiments with peat; discussion of methods of improving internal-combustion engine efficiency.

Construction, Far East. Dredge and Power-Plant Construction in the Far East, P. R. Parker. Eng. & Min. Jl.-Press, vol. 113, no. 119, May 13, 1922, pp. 807–812, 7 figs. Equipment purchased in U. S., modeled on California gold practice, a success in dredging for stream tin in Malay states; difficulties of transportation and installation solved.

Cost Cutting in Industrial. Cost Cutting for Industrial Power Plants, David Moffat Myers. Indus. Management, vol. 63, nos. 3, 4 and 5, Mar., Apr. and May 1922, pp. 140–142 and 170, 234–237, 304–309, 4 figs. Mar.: How to discover and correct boiler-plant wastes. Apr.: Determining present results and possible improvements. May: Methods of improving performance.

Design. Developments in Power Station Design. Engineer, vol. 133, no. 3457, Mar. 31, 1922, pp. 347–350, 9 figs. Describes condensers and their auxiliaries put on market by G. & J. Weir, Ltd., Glasgow, Scotland.

Five Pacific Coast Projects. Five Pacific Coast Water-Power Projects Licensed by Commission. Elec. World, vol. 79, no. 17, Apr. 29, 1922, p. 850. Plants at Kaweah River outside Sequoia Nat. Park, on San Joaquin River in Fresno and Madera Counties, on Snow Creek, Riverside County, at Delta, Cal., and on Clackamas River, Clackamas County, Oregon, to be developed.

Industrial, Layout for. Laying Out a Power and Heating System for an Industrial Plant, Chas. L. Hubbard, Southern Engr., vol. 37, no. 3, May 1922, pp. 47–51, 7 figs. Piping layout from boiler to engine and pumps, heating system, supply and return, and fire protection.

Operation. Higher Steam Pressures or Pulverized Coal? Frederick A. Scheffler. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 5, May 1922, pp. 346–350, 1 fig. Assumes a hypothetical power or public service steam plant of 100,000-kw. nominal capacity and compares cost of operation of such a plant on basis of 250 lb. pressure and 600 deg. fahr. total steam temperature, and 400 lb. pressure and 700 deg. fahr. total steam temperature, when fired by stokers and pulverized coal.

Sweden. Swedish State Power Plants (Die Kraftwerke des schwedischen Staates). Elektrotechnischer Anzeiger, vol. 39, nos. 57–58 and 59, Apr. 12 and 13, 1922, pp. 491–492 and 501–502, 6 figs. Construction and equipment of Motala power station recently opened, which, in conjunction with power stations at Trollhättan, Alfkarleby and Porjus, supplies power to state railways and various industries.

Utica State Hospital. Power and Heating Plant of Utica State Hospital. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 449–456, 12 figs. Description of central installation to supply heat, light, water, and power for institution approaching proportions of a city.

POWER TRANSMISSION

Oil. Power Transmission by Oil (Elaulic Gear), H. S. Hele-Shaw. Oil Eng. & Finance, vol. 1, no. 1, Jan. 14, 1922, pp. 59–68, 16 figs. Description of oil-variable-gear which is newest of special type.

Rope Drive. Power Transmission by Rope Drive, A. D. Welkinson. Southern Engr., vol. 37, no. 3, May 1922, pp. 35–37, 5 figs. Many textile mills are driven by means of rope-drive system. Multiple drive is dealt with in this article.

Types of Drives. Progress and Problems in Mechanical Transformation of Energy (Fortschritte und Probleme der mechanischen Energie-Umformung), K. Kutzbach. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 7 and 8, Feb. 18 and 25, 1922, pp. 154–159 and 183–185, 26 figs. Deals with indirect converter types. Status of belt and rope drive for long-distance conversion; increasing use of stretching pulleys for safe control of external tensions; problem of slip and friction, durability and bending losses The Föttinger and the Lentz converters and their use for all kinds of vehicles.

PRESSES

Inclinable. The Use of Inclinable Power Presses. Machy. (Lond.), vol. 19, no. 496, Mar. 30, 1922, pp. 787–788, 3 figs. Inclination of presses; classes of work readily performed on inclinable presses.

PULLEYS

Driving for Hydro-Extractor. Driving Pulley for Hydro-Extractor. Textile World, vol. 61, no. 16, Apr. 22, 1922, p. 41, 3 figs. Centrifugal clutch pulley which does not put load on motor until it has attained good speed.

PULVERIZED COAL

Combustion. The Carrying of Dust by a Current of Air (Etude de l'entrainement de poussièrepar un courant d'air), E. Audibert. Annales des Mines, vol. 1, no. 3, Mar. 1922, pp. 153–191, 3 figs. Discusses question of pulverized coal, especially arrangement of combustion chamber so as to assure complete combustion of dust.

Office-Building Heating. Powdered Fuel. Nat. Engr., vol. 26, no. 5, May 1922, pp. 219–221, 1 fig. Results from installation in 42-story L. C. Smith building, Seattle, Wash.

Power Plants. Lakeside Power Station at Milwaukee. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 397–406, 12 figs. Mechanical, electrical and construction features of world's largest pulverized fuel burning power plant.

Steam Boilers for. Powdered Coal under Steam Boilers, H. D. Savage. Coal Trade Jl., vol. 52, nos. 36, 37, 38, 39, 40 and 41, Sept. 7, 14, 21, 28, Oct. 5 and 12, 1921, pp. 1003–1004, 1028–1029, 1049–1051, 1074, 1094–1095 and 1116–1117, 5 figs. Progress made in making powdered coal for steam production thoroughly reliable and efficient, and economic possibilities of this method of combustion.

Treatment and Use. A New Pulverised Fuel Plant. Iron & Coal Trades Rev., vol. 104, no. 2821, Mar. 24, 1922, pp. 418–419, 2 figs. Describes coal drier, conveyance and distribution of pulverized fuel, hopper and controller system.

PUMPS

Semi-Solid Handling. A Pump that Handles Semi-Solids. Elec. News, vol. 31, no. 9, May 1, 1922, p. 51, 2 figs. Particularly designed to pass unscreened sewage; rags, cotton waste, fiber and all kinds of pulp and trade effluent from textile works in general. Made in England.

PUMPS, CENTRIFUGAL

Balancing, Automatic Method. Centrifugal Pumps, E. T. Keenan. Southern Engr., vol. 37, no. 3, May 1922, pp. 40–43, 7 figs. Automatic method of balancing; efficiency and losses.

PYROMETERS

Non-Ferrous Foundry. Pyrometry in the Non-Ferrous Foundry. Eng. Production, vol. 4, no. 81, Apr. 20, 1922, p. 365, 1 fig. Notes on thermo-electric, resistance, radiation and optical pyrometers.

R

RAILS

Russian 95-lb. The New 47 kg/m Rails of the Russian State Railways (Neue 47 kg/m schwere Schiene der russischen Staatsbahnen), C. Oppenheim. Organ für die Fortschritte des Eisenbahnwesens, vol. 77, no. 3, Feb. 1, 1922, pp. 38–39, 2 figs. Describes in detail profiles of these new rails intended for very heavy traffic, and compares with rails in other countries.

Deformation, Measuring. Measuring Rail Deformation by Moving Picture Photography. Ry. Rev., vol. 70, no. 14, Apr. 8, 1922, pp. 483–484, 6 figs. partly on p. 485. Describes method for making observations of rail depression under a moving load by means of moving picture camera, and gives results of series of tests made on St. Louis-San Francisco Ry.

Steel, Rolled Manganese. Rolled Manganese Steel Rails. Ry. Gaz., vol. 36, no. 14, Apr. 7, 1922, pp. 597 and 601, 2 figs. Advantages claimed for built-up railway track work. Discusses layout of "Imperial" patent rolled manganese steel rails of Waterloo Station, Lond. & South Western Ry.

RAILWAY ELECTRIFICATION

Inductive Interference and Electrolysis. The Question of Inductive Interference and Electrolysis Relating to Railroad Electrification. Chas. F. Scott. Elec. Jl., vol. 19, no. 4, Apr. 1922, pp. 146–149. Consideration of various ways in which telephone service has been interfered with and pipe lines corroded, and means of overcoming difficulties.

Italy. Electrification of the Italian Railways (L'Elettrificazione delle Ferrovie Italiane), C. Vita-Finzi. Elettricista, vol. 4, nos. 5 and 6, Mar. 1 and 15, 1922, pp. 37–38 and 44–46, 1 fig. Discusses electric traction, and necessity for Italy to electrify; new law for electrification of railroads. Gives list of trunk lines already electrified and list of lines to be electrified.

Single-Phase Overhead System. The Lancaster-Morecambe-Heysham Electric Railway. Electrician, vol. 88, nos. 2281 and 2282, Feb. 3 and 10, 1922, pp. 124–129 and 155–156, 8 figs. Experiences of 14 years' working with single-phase overhead system. Failures and modifications which have been necessary in various parts of apparatus during the 14 years.

RAILWAY MOTOR CARS

New Features. New Features in Service Railway Motor Coach. Ry. Age, vol. 72, no. 18, May 6, 1922, pp. 1069–1070, 3 figs. Service Motor Truck Co., Wabash, Ind., produces coach in which power plant and transmission follow regular motor truck practice but running gear is unique.

Operating Costs. Motor Trucks Operate on Rails in City and Interurban Passenger Service. Mun. & County Eng., vol. 62, no. 4, Apr. 1922, pp. 18–22, 1 fig. City and Interurban Ry. Co., Manhattan, Kansas, has recently scrapped heavy electric cars and now operate four FWD railway cars.

Problems. Modern Motor Rail Cars and the Local Passenger Problem, L. G. Plant. Ry. Rev., vol. 70, no. 15, Apr. 15, 1922, pp. 519–522, 2 figs. General problems involved in successful adaptation of modern rail car to steam railway service.

RAILWAY OPERATION

Auxiliary Train Control. The Sprague System of Auxiliary Train Control. Ry. Age, vol. 72, no. 16, Apr. 22, 1922, pp. 963–967, 9 figs. Apparatus undergoing daily test on section of New York Central operates on normal danger plan and leaves engineer practically undisturbed while on duty.

Reversible Steam Train. "Reversible" Steam Train, London & North Western Railway. Ry. Gaz., vol. 36, no. 17, Apr. 28, 1922, pp. 697–699, 5 figs. Describes push-and-pull train which has been working satisfactorily on local service in England.

Train Control. Automatic Train Control in America. Ry. Gaz., vol. 36, no. 16, Apr. 21, 1922, pp. 658. Some observations on Interstate Commerce Commission suggestions in accordance with Sec. 26 of Transportation Act advising full equipment over one passenger division by July 1, 1924.

Railroads Argue Against Automatic Stops at I. C. C. Hearing. Ry. Signal Engr., vol. 15, no. 4, Apr. 1922, pp. 151–158. Railroads claim that no automatic train stop or train-control device has been sufficiently developed to warrant installation on such extensive scale as is outlined in proposed order of Interstate Commerce Commission and that Am. Ry. Assn. is working for development of a practical device.

RAILWAY REPAIR SHOPS

Freight Cars. Rip Track Equipment and Methods on Ft. D. D. M. & S. Ry. Rev., vol. 70, no. 14, Apr. 8, 1922, pp. 491–495, 11 figs. Equipment and management of new freight-car repair yard and methods of repairing.

RAILWAY SHOPS

Equipment. What Shop Equipment Means to a Railroad, V. Z. Caracristi. Central Ry. Club Official Proc., vol. 30, no. 2, Mar. 1922, pp. 1156–1167 and (discussion) 1168–1182, 2 figs. Discusses expenditures necessary to take care of locomotives and cars coming immediately under jurisdiction of motive power department; gives charts and tables.

RAILWAY SIGNALING

Belgium. Signaling on the Belgian State Railways (La signalisation des chemins de fer de l'état Belge), Lucien Pahin. Génie Civil, vol. 80, no. 11, Mar. 18, 1922, pp. 253–255, 3 figs. Describes fixed signal system, positions of arms, colored lights, and shows how dangerous points are guarded by signals.

Facing Points, Long-Distance Operation. Long-Distance Operation of Facing Points. Ry. Gaz., vol. 36, no. 13, Mar. 31, 1922, p. 561, 3 figs. Relates how colliery company has been first in England to work facing points 500 yards distant direct from signal box electrically by primary batteries, providing ready and comparatively cheap means towards converting refuge sidings into running loops.

Unlocking by Tablet. Unlocking the Starting Signal for Entering a Single Line Section by the Tablet. Ry. Engr., vol. 43, no. 507, Apr. 1922, pp. 133–139, 1 fig. Only railway company which consistently unlocks all single line starting signals by tablet is London & South-Western. Description of original and present method employed.

RAILWAY TIES

Tamping Machine. Tamping Machine for Railroad Ties (Machine para soccar o lastro sob os dormentes). Revista Brasileira de Engenharia, vol. 3, no. 2, Feb. 1922, pp. 79–80, 2 figs. Describes machine made by Serva & Cia., S. Paulo, consisting of a hammer for tamping ballast and a gasoline engine for driving hammer.

RAILWAY TRACK

Construction. Adjusting Track Construction to the Lightweight Car, R. G. Taber. Elec. Ry. Jl., vol. 59, no. 18, May 6, 1922, pp. 755–756, 1 fig. Account of two track jobs recently completed in Fort Worth, in which advantage was taken of light weight of Birney cars operated there in cheapening construction. (Abstract.) Paper read before Southwestern Elec. & Gas Assn.

Curves. The Design of Transition Curves for Railway Tracks (Zur Konstruktion des Uebergangsbogens für Eisenbahngleise), K. Lachmann and R. Rothe. Zeit. für angewandte Mathematik u. Mechanik, vol. 2, no. 1, Feb. 1922, pp. 45–78, 8 figs. It is claimed that methods of practical mathematics permit accurate solution of problem, not only for flat curves, but for transition curves for any given differences in direction.

Rack Type. Rack Wheel and Branch Lines (Zahnradanschlussbahnen), A. Wichert. Schweiz. Elektrotechnischer Verein Bul., vol. 13, no. 3, Mar. 1922, pp. 98–106, 6 figs. Describes cog-wheel electric locomotive of Oker Metal and Color Works, in Harz Mountains, and loading and unloading arrangements at works with a difference in levels of 24 meters.

Shifting Machine. Track Shifting Machine, Friedr. Hübener. Eng. Progress, vol. 3, no. 4, Apr. 1922, p. 87, 2 figs. Describes Arbenz-Kammerer type, consisting essentially of portable bridge resting on two bogies; center of bridge carries frame which may be shifted over laterally.

RAILWAYS

Czechoslavakia. The Railways of Czechoslavakia (Trois années d'existence des chemins de fer Tchécoslovaques), Paul Koller. Révue Générale des Chemins de Fer et des Tramways, vol. 41, no. 4, Apr. 1922, pp. 276–290, 1 fig. Discusses post-war situation, rolling stock, workshops, coal shortage, finances, etc.

Chinese Government. Administration of Chinese Government Railways, Ching-chun Wang. Ry. Rev., vol. 70, no. 17, Apr. 29, 1922, pp. 600–605, 2 figs. Railway developments in China and details of Central Administration controlling them. From Jl. Assn. Chinese & Am. Engrs.

Italy. Italian Railways. Ry. Gaz., Special Italian Railway Number, Apr. 18, 1922, pp. 5–32, 102

figs. partly on pp. 33–69. (In Italian and English.) Detailed description of state railways, including administrative management and staff, passenger fares and train service, freight traffic, engineering questions, rolling-stock, etc.

Russia. Present State of Railroad Transportation in Russia, U. I. Lebedeff. (In Russian.) Supp. to Eng. News of Scientific and Technical Council of Russian Eng. Assn., Jan. 1919, 8 pp., 12 figs. Statistical data on Russian railroads as they were at end of 1918.

REFRACTORIES

Softening Temperature, Determining. A New Device for Determination of the Softening Temperature of Refractory Materials under Load (Eine neue Vorrichtung zur Bestimmung der Erweichungstemperatur von feuerfesten Materialien unter Belastung), W. Steger. Berichte der Deutschen Keramischen Gesellschaft, vol. 3, no. 1, Feb. 1922, pp. 1–4, 1 fig. Describes press and heating device developed by author for use in Chemical-Technical Experimental Station of the State Porcelain Mfg. Works, Berlin-Charlottenburg.

REFRIGERATING MACHINES

Carbon Dioxide. The Operation of CO_2 Marine Refrigerating Machines in Warm Seas (Du fonctionnement des machines frigorifiques marines a acide carbonique dans les mers chaudes). Bul. Technique du Bureau Veritas, vol. 4, no. 2, Feb. 1922, pp. 43–44, 1 fig. Difficulties arising from fact that critical point of CO_2 is 31.35 deg. and temperature in warm seas sometimes is above 30 deg., and describes Le Blanc method of overcoming difficulties, consisting simply of cooling condensing water by installing between sea and condenser of CO_2 machine, a vacuum evaporator.

REFRIGERATING PLANTS

Ammonia Fittings, Standardization of. Standardization of Ammonia Fittings Necessary, Erwin Bunzel. Power, vol. 55, no. 15, Apr. 11, 1922, p. 581. Pointing out necessity of early adoption of code covering standardization of flanges for refrigerating systems.

REFRIGERATION

Meat Industry. Refrigeration and the Meat Industry, W. H. Medcalf. Cold Storage & Ice Assn. Proc., vol. 18, no. 1, 1921–22, pp. 69–83 and (discussion) pp. 84–90. Indicates general uses to which refrigeration is applied at present time.

ROLLING MILLS

Electric Drive Troubles. Where to Look for Things that Cause Trouble in Reversing-Roll Electric Drives, Arthur J. Whitcomb. Elec. Rev. & Indus. Engr., vol. 80, no. 2, Feb. 1922, pp. 63–66, 103, 8 figs. Maintenance practice in reversing roll electric drives.

RUBBER

Machinery, Developments in. Modern Developments in Rubber Machinery, J. W. Howie. India-Rubber Jl., vol. 63, nos. 15 and 16, Apr. 15 and 22, 1922, pp. 17–25 and 13–18 and (discussion) 18–19, 40 figs. Apr. 15: Some recent improvements. Apr. 22: Vulcanizing, type making, hose covering and special plant. Paper read before Instn. Rubber Industry, at Royal Soc. Arts.

Magnesium Carbonate Compounded with. Some Physical Properties of Rubber Compounded with Light Magnesium Carbonate, H. W. Greider. Jl. of Indus. & Eng. Chem., vol. 14, no. 5, May 1922, pp. 385–395, 22 figs. Data showing increase in tensile strength, hardness and resilient energy and probability of eliminating principal disadvantages by compounding filler in amorphous form.

Transparent. Rubber Glass—A New Product of Great Interest. India Rubber World, vol. 66, no. 2, May 1, 1922, pp. 538–539. Description of invention of Fordyce Jones, giving its advantages and limitations.

Vulcanization. Cold Vulcanization of Rubber, S. J. Peachey. Rubber Age, vol. 3, no. 2, Apr. 1922, pp. 61–66. Paper read before Inst. of Rubber Industry, London, on this method of determination with gases and advantages of same.

S

SAFETY ENGINEERING

Graphic Charts. Obtaining and Presenting Safety Statistics for the Busy Executive, A. M. Underhill. Safety Eng., vol. 43, nos. 4 and 5, Apr. and May 1922, pp. 131–134, 199–204, 7 figs. Apr.: Methods of presenting statistics for determining what steps may be taken to prevent repetition of accidents in such form that they become intelligible to executives not familiar with work. May: Use of logarithmic paper for curve charts clearly shows accident increase or decrease.

SAND BLAST

Plants and Methods. Sand Blasting, E. L. Samson. Foundry Trade Jl., vol. 25, nos. 287 and 288, Feb. 16 and 23, 1922, pp. 115–118 and 143–144, 19 figs. High- versus low-pressure plants; abrasive power considerations; cost of sand blasting; sand-blast rooms, cabinets and tumbling barrels; sand-blast conveyors; dust collecting; etc. Paper read before Instn. British Foundrymen.

SAND, MOLDING

Dressing. The Dressing of Moulding Sand, Heinz Kalpers. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 79–81, 5 figs. Notes on dressing of fresh sand, used sand and coal dross; drying furnaces for fresh sand; shaking sieves; sand-crushing mills with magnetic rollers; automatic dressing plants.

Preparation. Sand Offers Field for Improvement, Eugene W. Smith. Foundry, vol. 60, no. 7, Apr. 1, 1922, pp. 264–265. Factors besides physical characteristics and chemical analysis entering into preparation, classification and grading of sand used in preparation of molds into which metal is poured. From paper read before Chicago Foundrymen's club.

SCRAP

Deleading. Removing Lead from Scrap Metals (Das Entbleien von Altmetallen) Metall—Technik, vol. 48, no. 10, Mar. 4, 1922, pp. 92–93. Discusses wet and dry methods and describes operations.

Metal, Dezincification. Dezincing of Scrap Metal (Das Entzinken von Altmetallen, B. Haas. Zeit. für die gesamte Giessereipraxis, vol. 43, no. 12, Mar. 25, 1922, p. 154. Thermal and chemical processes used. Concludes that dezincification is more reliable and simpler than deleading.

SEAPLANES

Facilities on Atlantic Coast. Seaplane Facilities on the Atlantic Coast. Aviation, vol. 12, no. 18, May 1, 1922, pp. 506–507. Thirty-nine landing places for seaplanes listed in survey issued by Nat. Advisory Com.

SEMI-DIESEL ENGINES

Two-Cylinder Marine. New Two-Cylinder Semi-Diesel Marine Oil Engine. Oil Eng. & Finance, vol. 1, no. 2, Mar. 25, 1922, pp. 369–370, 1 fig. Design for small commercial vessels two-cycle hot-bulb developing 30 b.hp. at 425 r.p.m.

SHERARDIZING

Factors Influencing Process. Factors Influencing the Process of Sherardizing, Leon McCulloch. Elec. Jl., vol. 19, no. 4, Apr. 1922, pp. 156–160, 4 figs. Experiments in features not hitherto definitely known. Growth of coating, effect of iron in zinc dust; effect of other metals in zinc dust; composition of coatings.

SMOKE ABATEMENT

Water Grates. Abatinga Smoke Nuisance, R. R. Hillman. Power Plant Eng., vol. 26, no. 9, May 1, 1922, pp. 463–465, 3 figs. Treatment of an unique case in department store in Buffalo where water grates also increased circulation of boiler water.

SOOT BLOWERS

Steam Consumption. Steam Used for Soot Blowing, Robert June. Power Plant Eng., vol. 26, no. 8, Apr. 15, 1922, pp. 414–415, 4 figs. Method of calculating steam consumption when time valve is open is known. See also Power House, vol. 15, no. Apr. 5, 1922, pp. 30–31, 4 figs.

SPECIFIC HEAT

Gas. The Specific Heats of Gas From the Point of View of Their Industrial Application (Sur les chaleurs spécifiques des gaz envisagées au point de vue de leur application aux problèmes industriels), Emilio Damour and D. Wolkowitsch. Révue de Métallurgie, vol. 19, no. 3, Mar. 1922, pp. 145–161, 2 figs. Reviews in detail literature on subject, and shows that there is no agreement between the various authorities.

SPRINGS

Impact, Absorption of. Graphic Representation of Absorption of Impact by Springs. Machy. (Lond.), vol. 20, no. 499, Apr. 20, 1922, pp. 93–94, 2 figs. Description of graphic method to determine energy absorbed under certain simple conditions.

Laminated. General Theory of Laminated Springs (Allgemeine Theorie der Blattfeder), Y. Tanaka. Zeit. für angewandte Mathematik u. Mechanik, vol. 2, no. 1, Feb. 1922, pp. 26–34, 6 figs. Deals with equilibrium of laminated springs under influence of an inclined load, taking into consideration friction and initial pressure between the plates, differing strength and shape of plates and curvature of spring.

STACKS

Venturi. New Stack Type, A. W. H. Griepe. Am. Gas Jl., vol. 116, no. 15, Apr. 15, 1922, pp. 343–346, 18 figs. New type similar in shape to a venturi tube combined with blower has advantage of flexibility of operation, and low cost of installation and maintenance.

STANDARDIZATION

Reducing Cost. Reducing the Cost of Standardization, W. O. Lichtner. Management Eng., vol. 2, no. 5, May 1922, pp. 275–280. Need and possibilities of handbook of times for performing manufacturing operations including charts and tables showing elementary operations analyzed to simplest items.

STAYBOLTS

Failure. Defective Staybolts Cause Locomotive Disaster, A. G. Pack. Boiler Maker, vol. 22, no. 4, Apr. 1922, pp. 97–99, 3 figs. Report of failure of Pennsylvania R. R. locomotive, submitted to Interstate Commerce Commission. Explosion partly due to heavy grooving of back head at mud ring.

STEAM

Generation, Distribution and Use. The Generation, Transmission and Use of Steam (Dampferzeugung, Dampffortleitung und Dampfverwendung), H. Laaser. Wärme (Zeit. für Dampfkessel u. Maschinenbetrieb), vol. 45, no. 1, Jan. 6, 1922, pp. 1–3. Notes on economic steam generation; steam distribution and conduction; and use of steam for generation of power and of steam for cooking and heating purposes.

High-Pressure. Higher Steam Pressures, Joseph Jares. Combustion, vol. 6, no. 5, May 1922, pp. 221–223, 1 fig. Consensus of opinion of most writers favors higher pressures and temperatures. Advantages. Letters from C. J. Stover, Sec'y of Magnesia Assoc. of Am., and W. S. Lockwood, of Johns-Manville, Inc.

The Properties of Steam under High Operating Pressures (Bemerkungen zu den Eigenschaften des Wasserdampfes bei hohen Betriebsdrücken), G. Eichelberg. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 12, Mar. 25, 1922, pp. 275–277, 6 figs. Differences in the values for heat of evaporation obtained by Schüle and Eichelberg. Possibility of indirect measurement of specific heat of saturated steam based on relation between exponent of the adiabatic curve, heat of evaporation and specific heat.

Metering of. The Metering of Steam, John L. Hodgson. Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 466–468, 5 figs. Steam meters developed by author and his firm, Geo. Kent, Ltd., during last twelve years.

Specific Heat of Superheated. The Specific Heat of Superheated Steam for Pressures of 20 to 30 Atmos. (Die spezifische Wärme des überhitzten Wasserdampfes für Drucke von 20 bis 30 at.), Osc. Knoblauch. Zeit. für technische Physik, vol. 3, no. 2, 1922, pp. 39–40. Results of tests carried out in conjunction with E. Raisch.

STEAM ENGINES

Heat Economy. Using the Heat of Piston Steam Engines to Best Advantage (Die Wärmeausnutzung der Kolbendampfmaschine), W. Schmidt and R. Wolf. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 14, Apr. 8, 1922, pp. 345–350, 4 figs. Discusses increase of pressure from 18 to 55 atmos., increase in expansion of steam, intermediate superheating, etc., on basis of latest experiments by W. Schmidt and R. Wolf.

Indicator Diagrams. Indicator Diagrams. Power, vol. 55, no. 15, Apr. 11, 1922, pp. 574–576, 28 figs. Contains diagrams from Corliss, uniflow and non-releasing four-valve engines.

Uniflow. Uniflow Blooming-Mill Engine. Eng. Progress, vol. 3, no. 4, Apr. 1922, pp. 69–71, 6 figs. Effect of inlet condensation; different principles of uniflow action. The Demag uniflow engine with two rows of slits. Comparisons with long-piston engine.

STEAM PIPES

High-Pressure. Safety in High-Pressure Piping of Steam Power Plants (Die Sicherheit beim Betrieb von Hochdruckrohrleitungen in Dampfkraftanlagen), H. Menk. Wärme, vol. 45, no. 4, Jan. 27, 1922, pp. 56–59, 11 figs. Discusses measures and devices employed for increasing safety in use of such pipes.

STEEL

Defective Points, X-Ray Examination. Fundamentals for Determination of Defective Points in Steel by Means of X-Rays (Grundlagen für die Feststellung von Fehlstellen in Stahl mittels Röntgenstrahlen), E. H. Schulz. Stahl u. Eisen, vol. 42, no. 13, Mar. 30, 1922, pp. 492–496, 19 figs. Describes apparatus for examination with X-rays, and results obtained; depth of irradiation; investigation of welding points.

Molybdenum. See MOLYBDENUM STEEL.

Structural. See STRUCTURAL STEEL.

X-Ray Examination. X-Ray Investigations of the Structure of Steel Ingots and Billets (Röntgenstrukturuntersuchungen an Blöcken und Knüppeln), Fr. Heinrich. Stahl u. Eisen, vol. 42, no. 14, Apr. 6, 1922, pp. 540–542, 6 figs. Results of tests carried out according to the Laue process. X-ray photographs are presented and described. In a second article by R. Glocker, the technical application of process is described (pp. 542–543, 2 figs.) Discussion of both articles, pp. 543–545.

[See also IRON AND STEEL; METALS.]

STEEL, HEAT TREATMENT OF

Ball Bearings. Ball Bearing Steel and its Heat Treatment, Carl T. Hewitt. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 196–198, 4 figs. Use of steels of from 0.60 to 1.5% per cent chromium content to meet extreme service demands. Methods of annealing and of hardening.

Hardening in Tempering Furnace. The Hardening of Steel Parts in Tempering Furnace (Das Härten von Eisenteilen im Hérteofen). Zeit. für die gesamte Giessereipraxis, vol. 43, nos. 10 and 11, Mar. 11 and 18, 1922, pp. 129–131 and 142–144. Notes on proper design of furnace and methods of hardening.

Problems. Heat Treatment Problems—II, Leslie Aitchison. Metal Industry (Lond.), vol. 20, no. 5, Feb. 3, 1922, pp. 113–115, 3 figs. Deals with problems of cooling.

Tests. Relation of Time for Heating Round Sections to Surface per Lb. of Steel Exposed, E. J. Janitzky. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 179–181, 2 figs. Discusses experiments carried on by M. E. Leeds, results having been presented in paper, "Some Neglected Phenomena in the Heat Treatment of Steel," before Am. Soc. for Testing Mtls. and published in A.S.T.M. Proc., vol. 15, 1915.

STEEL MANUFACTURE

Basset Process. Blast Furnace Eliminated from Steel Making. Indian Industries & Power, vol. 19, no. 7, Mar. 1922, pp. 235–236. Some unsubstantiated reports of process discovered by Basset for producing steel direct from ore. Being tried out in Sheffield.

STEEL WORKS

British. Famous British Works. Eng. Production, vol. 4, nos. 77 and 78, Mar. 23 and 30, 1922, pp. 266–268 and 290–292, 9 figs. Describes works of Arm-

strong, Whitworth & Co., Ltd., shipbuilders and manufacturers of locomotives, marine engines, brass and non-ferrous metals, steel products, pneumatic tools, etc. Mar. 23: The Openshaw works devoted chiefly to manufacture of steel, armor plate, machine tools, etc. Mar. 30: The North Street works, representing later extensions to Openshaw works, and including large steel departments.

Electric, Southern Pacific Shops. Electric Steel Plant at the Southern Pacific Shops, Larry J. Barton, Chem. & Met. Eng., vol. 26, no. 18, May 3, 1922, pp. 838-840, 2 figs. Six-ton Heroult furnace produces all steel castings for large western railway as a side line. For a year it produced rivet steel from miscellaneous scrap, and now is working on order for 1,000,000 tie plates.

Power Plant. Power Plant Designed for Steel Mill Conditions. Power, vol. 55, no. 15, Apr. 11, 1922, pp. 566-570, 7 figs. Describes Inland Steel Co.'s plant no. 2, Indiana Harbor. Boilers are equipped with underfeed and forced-draft chain-grate stokers. Coke breeze,coal and coke-oven and blast-furnace gas used as fuel. Combination of four feedwater heaters operated in parallel.

STREET RAILWAYS

Controlling Excavations in Roadbed. Controlling Excavations Through Right-of-Way, R. B. Genest. Elec. Ry. Jl., vol. 59, no. 17, Apr. 29, 1922, pp. 703-707, 17 figs. Montreal, Que., system wherein railway sanctions digging operations affecting its track and is compensated for expense therewith.

France. Present State of the Tramway Industry (État actuel de l'Industrie des Tramways), Roger Vente. Révue Industrielle, vol. 52, no. 6, Apr. 1922, pp. 183-189, 13 figs. Describes present practice in Paris, construction of tracks, rails, rolling stock, first and second class cars.

France. Present Technical State of Tramways. Industrie des Tramways, vol. 15, no. 177-178/179-180, Sept.-Oct./Nov.-Dec. 1921, pp. 149-355 (contains figs.). A series of reports presented before 2nd General Technical Meeting of Tramways Association in France, on rail profiles, frogs and crossings, track laying, curve construction, standardization of rolling stock, safety and comfort, power transmission, electrification of local railroads, etc.

Track. Expediting Track Construction in Toronto. Elec. Ry. Jl., vol. 59, no. 13, Apr. 1, 1922, pp. 551-558, 31 figs. Describes work in connection with relaying of tracks; gives standards of Toronto Transportation Commission.

STRUCTURAL STEEL

Wheels from I Beams. Fabrication of First Structural Steel Wheel, W. R. Ward. Forging & Heat Treating, vol. 8, no. 4, Apr. 1922, pp. 184-188, 13 figs. Difficulties encountered and problems solved in early experimental stage of construction of "I"-beam structural steel wheel.

SPARK PLUGS

Weaknesses. Sparking Plugs. Automobile Engr., vol. 12, no. 162, Apr. 1922, pp. 105-106, 6 figs. Five points to be considered in designing.

STANDARDIZATION

Domestic and European Movements. Recent Domestic and European Standardization Movements. Automotive Industries, vol. 46, no. 17, Apr. 27, 1922, pp. 912-913. Chains, tires and rims, petroleum, varnish and lumber.

STOKERS

Correcting Troubles in. Draft, Joseph G. Worker. Combustion, vol. 6, no. 5, May 1922, pp. 232-234, 240, 4 figs. Main points from forthcoming book, Mechanical Stoker, by J. G. Worker and T. A. Peebles. Draft one of most important features in correcting stoker troubles.

Mechanical. The Principal Types of Mechanical Stokers. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 19-21, 6 figs. Discusses chain-grate, underfeed, and overfeed stokers. Choice of stokers.

Multiple Underfeed. A New Type of Multiple Underfeed Stoker, Robert June. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 35-37, 7 figs. Many advantages described and curves of both calculated and actual performance given.

Sprinkler. Sprinkler Stokers in a Mill Power Plant. Power House, vol. 15, no. 8, Apr. 20, 1922, pp. 24-25, 2 figs. Small type requiring practically no special brick work; readily applied to any style boiler without structural alterations.

SUBWAYS

New York. Subways for City Transportation with Important New York Details, Robert Ridgway. Elec. Ry. & Tramway Jl., vol. 46, no. 1125, Apr. 7, 1922, pp. 161-164, 7 figs. Review of development of system and comparison with other forms of transportation.

T

TERMINALS, RAILWAY

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Metal, Resistance of. New Method of Testing Wear in Metals (Nouvelle méthode d'essai des métaux a l'usure), L. Jannin. Révue de Métallurgie, vol. 19, no. 2, Feb. 1922, pp. 109-116, 11 figs. Describes machine for testing resistance of axle and bearing metals to wear. Pages 117-119, article by Leon Guillet on some friction tests carried out with the Jannin wear-testing machine.

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Manufacture of Small. A Small Tools Factory. Eng. Production, vol. 4, no. 78, Mar. 30, 1922, pp. 307-311, 14 figs. Describes equipment in works of C. A. Vandervell & Co., Ltd.

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WASTE PREVENTION

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Canada. Installed Water Wheel Capacity in Canada Totals 2,763,000 hp. Contact Rec., vol. 63, no. 16, Apr. 19, 1922, pp. 344-346. Résumé of water power resources of Dominion, brought up to date by Water Power Branch, Dept. of Interior, shows 300,000 hp. added during 1921.

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Autogenous. See AUTOGENOUS WELDING.

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Motor-Generator Repairs. Welding Reduces Cost of Repairing Motor Generators. Elec. World, vol. 79, no. 18, May 6, 1922, pp. 885-886, 1 fig. Account of repairs at Bryant St. Sub-station of Market St. Rys. of San Francisco, by use of welding.

Oxy-Acetylene. See OXY-ACETYLENE WELDING.

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ZINC

Extraction. New Methods for Extracting Zinc From Its Ores (Nuovi processi di estrazione dello zinco dai suoi minerali), Gaetano Castelli. Rassegna Mineraria Metallurgica e Chimica, vol. 56, no. 2, Feb. 28, 1922, pp. 21-24, 3 figures. Discusses new method using a reverberatory furnace and an improved bisulphite method, and gives diagrams of operations.

Research. Research Work on Zinc and Zinc Alloys, Wallace Dent Williams. Can. Foundryman, vol. 13, no. 3, Mar. 1922, pp. 26-27 and 30, 8 figs. Discusses alloys with high percentage of zinc replacing brass with favorable results.